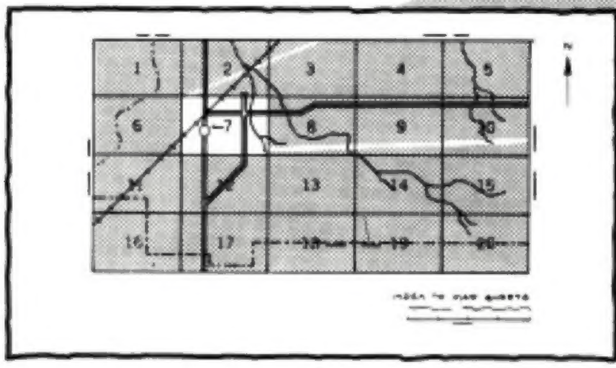
SOIL SURVEY OF

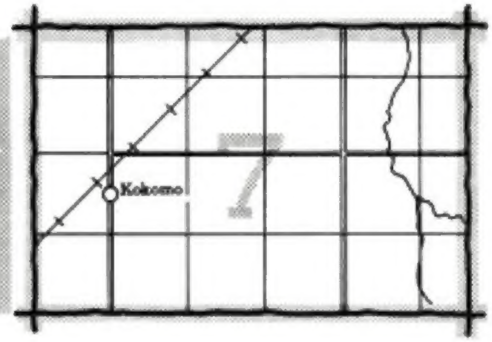
JACKSON COUNTY, KANSAS

United States Department of Agriculture
Soil Conservation Service
in cooperation with
Kansas Agricultural Experiment Station

HOW TO USE

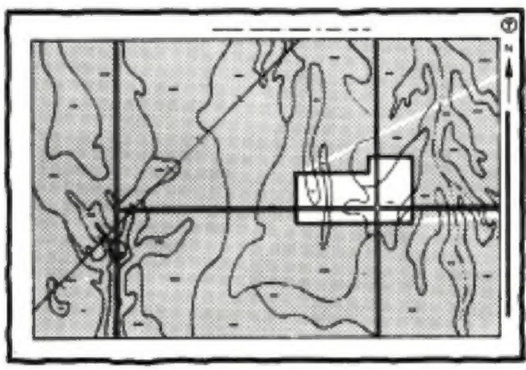
1. Locate your area of interest on the "Index to Map Sheets"

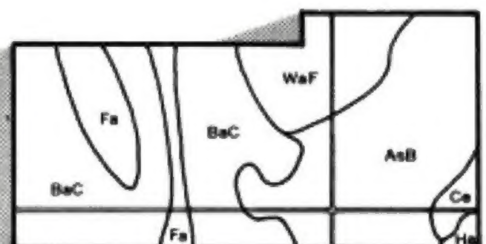




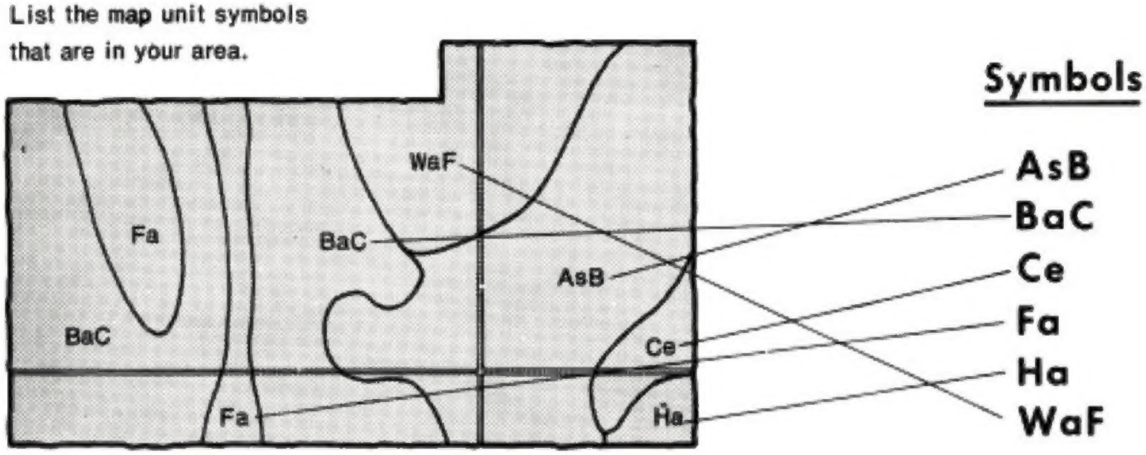
2. Note the number of the map sheet and turn to that sheet.

3. Locate your area of interest on the map sheet.



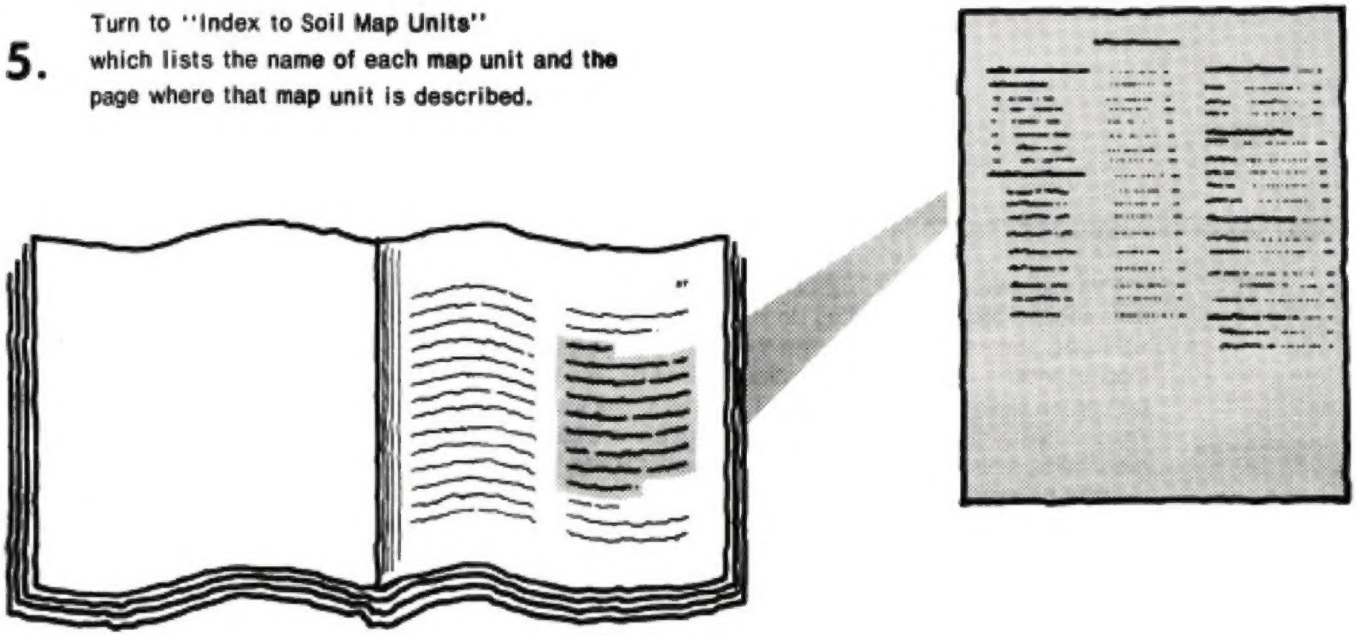


4. List the map unit symbols that are in your area.

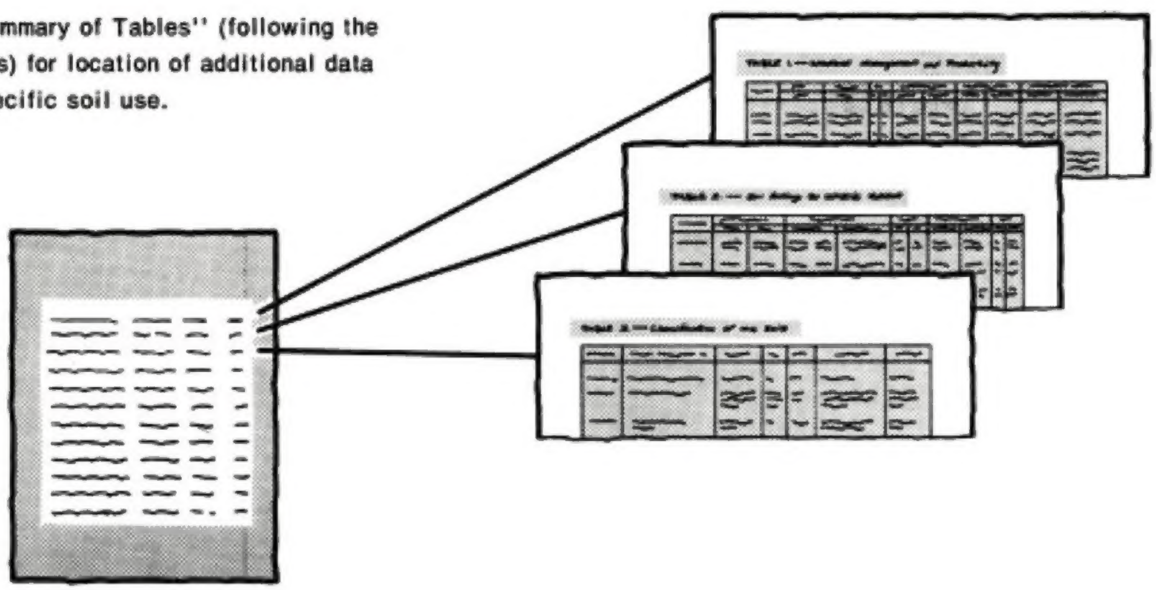


THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; to specialists in wildlife management, waste disposal, or pollution control.

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in the period 1965-1975. Soil names and descriptions were approved in 1975. Unless otherwise indicated, statements in the publication refer to conditions in the survey area in 1975. This survey was made cooperatively by the Soil Conservation Service and the Kansas Agricultural Experiment Station. It is part of the technical assistance furnished to the Jackson County Conservation District.

Soil maps in this survey may be copied without permission, but any enlargement of these maps can cause misunderstanding of the detail of mapping and result in erroneous interpretations. Enlarged maps do not show small areas of contrasting soils that could have been shown at a larger mapping scale.

Cover: Harvested hay in an area of Pawnee clay loam, 3 to 7 percent slopes. Strips of grass have been left to provide cover for wildlife.

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Issued April 1979

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Foreword

The Soil Survey of Jackson County, Kansas contains much information useful in any land-planning program. Of prime importance are the predictions of soil behavior for selected land uses. Also highlighted are limitations or hazards to land uses that are inherent in the soil, improvements needed to overcome these limitations, and the impact that selected land uses will have on the environment.

This soil survey has been prepared for many different users. Farmers, ranchers, foresters, and agronomists can use it to determine the potential of the soil and the management practices required for food and fiber production. Planners, community officials, engineers, developers, builders, and homebuyers can use it to plan land use, select sites for construction, develop soil resources, or identify any special practices that may be needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the soil survey to help them understand, protect, and enhance the environment.

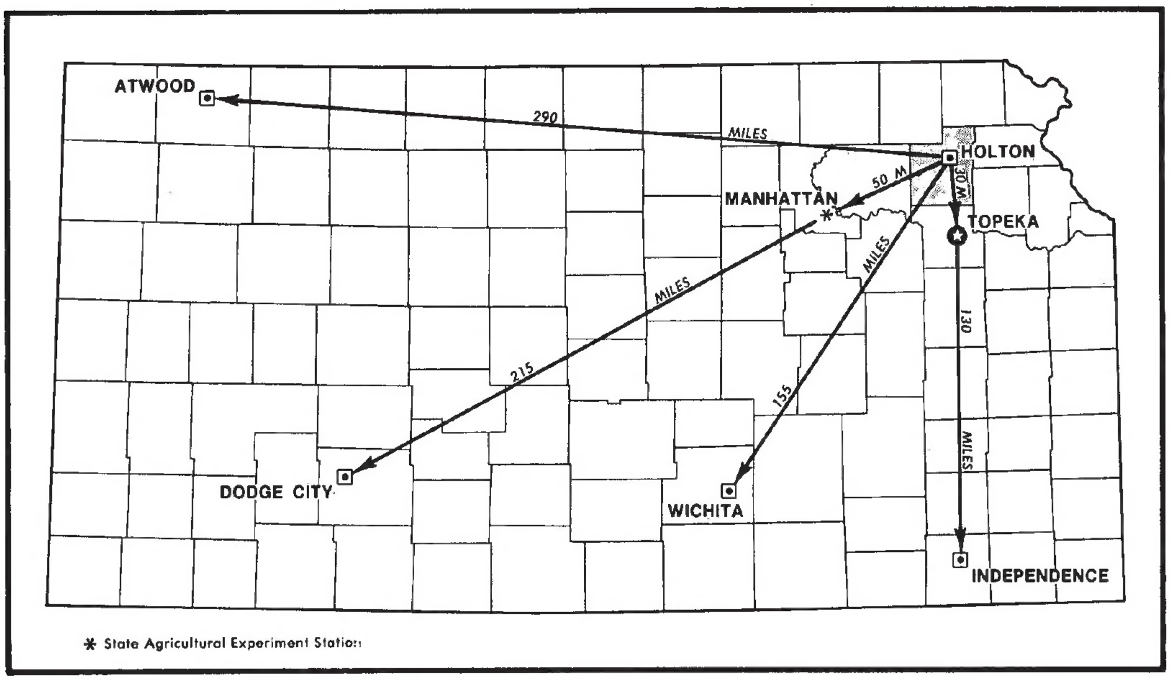
Great differences in soil properties can occur even within short distances. Soils may be seasonally wet or subject to flooding. They may be shallow to bedrock. They may be too unstable to be used as a foundation for buildings or roads. Very clayey or wet soils are poorly suited to septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map; the location of each kind of soil is shown on detailed soil maps. Each kind of soil in the survey area is described, and much information is given about each soil for specific uses. Additional information or assistance in using this publication can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

This soil survey can be useful in the conservation, development, and productive use of soil, water, and other resources.

Robert K Griffin

Robert K. Griffin
State Conservationist
Soil Conservation Service



Location of Jackson County in Kansas.

SOIL SURVEY OF JACKSON COUNTY, KANSAS

By Howard V. Campbell, assisted by Harold P. Dickey and Harold T. Rowland, Soil Conservation Service

United States Department of Agriculture, Soil Conservation Service, in cooperation with Kansas Agricultural Experiment Station

JACKSON COUNTY is in the northeastern part of Kansas (see facing page). It has a total area of 656 square miles, or 419,712 acres. Holton, in the central part of the county, is the county seat. The county was organized in 1887 and Holton in 1870 (*3*).

The population of Jackson County is about 11,245, of which 5,314 live in towns and 5,931 in rural areas (*4*). More than 500 commute to work from Jackson County to Topeka.

Farming and related services are the most important enterprises in the county. Corn, wheat, sorghum, soybeans, and alfalfa are the main crops. Beef cattle and swine are the main kinds of livestock. Dairy cattle, sheep, and poultry also are raised.

General nature of the county

This section gives general information concerning the county. It describes the physiography, drainage, and relief; the water supply; the natural resources; the climate; and farming.

Physiography, drainage, and relief

Jackson County lies within the Dissected Till Plains section of the Central Lowlands Physiographic Province and the Natural Land Resource Area known as the Nebraska and Kansas Loess-Drift Hills (*11*). The landscape is one of strongly rolling plains that are thoroughly dissected by numerous streams. The surface slopes gently to the southeast. The larger streams in the eastern part of the county flow in a general southeast direction, whereas those in the western and southern parts flow nearly straight south.

Big Soldier Creek is the longest stream in the county. Cross Creek is in the southwestern part. Walnut and Little Soldier Creeks have their headwaters in the Pottawatomie Indian Reservation. Mud Creek or South Muddy Creek drains the southeast corner of the county. Elk Creek, Spring-Straight Creek, North Muddy Creek, and Cedar Creek are tributaries to the Delaware River, which flows through the northeast corner.

Nearly level and gently sloping soils are adjacent to the major streams. Gently sloping to moderately sloping soils that formed in loess are on ridgetops and high benches. The largest areas of these soils are in the vicinity of Netawaka and Whiting. The glacial areas cover about a third of the county. Soils are gently sloping on ridgetops to very steep next to the wide, round valleys. The average local relief is less than 40 feet. Bedrock crops out in the western, southern, and eastern parts of the county; hills have flat tops and steep sides; and relief is more pronounced than in the glacial areas.

Water supply

The water supply in most of Jackson County varies. Most of the county derives water from wells that yield 1 gallon to 15 gallons per minute. Underlying alluvial deposits provide a fair supply of water for wells. In some areas ground water is not available or is in limited supply. An impoundment reservoir, in addition to wells, provides water to Holton.

Surface water is impounded by dams on streams that flow through many farms. This impounded water helps to supply water for livestock and, if a filter system is used, can supply water to farm homes. Rural water districts supply water to farms throughout most of the county.

Natural resources

Soil is the most important natural resource in the county. Livestock that graze the grassland and crops produced on farms are marketable products that are affected by the soil.

Limestone in Jackson County is suitable for many uses. It has been quarried and used as building stone or crushed for use as road-building material or agricultural lime. Several large quarries are in the county. No building-stone quarries are operated.

Sand and gravel pits provide a source of road-surfacing material. These deposits are of glacial origin and consist of unsorted sand and gravel mixed with clay and boul-

ders. These deposits of sand and gravel are in Shelby soils.

Very little coal has been mined in Jackson County. The supply of natural gas and oil is not large enough to be significant.

Climate

By L. DEAN BARK, climatologist, Kansas Agricultural Experiment Station, Manhattan, Kans.

The climate of Jackson County is typical continental, as would be expected of a location in the interior of a large land mass in the middle latitudes. Such a climate is characterized by large daily and annual variations in temperature. Winters are cold because of frequent advances of polar air. Winter conditions prevail in December, January, and February. Warm temperatures last for about 6 months every year, and spring and fall are short. The warm weather provides a long growing season for crops.

Jackson County is in the path of a fairly dependable current of moisture-laden air from the Gulf of Mexico. Precipitation is heaviest late in spring and early in summer. Much of it occurs as late-evening or nighttime thunderstorms. Although the total precipitation is generally adequate for any crop, its distribution can cause problems in many years. Prolonged dry periods of several weeks duration are not uncommon during the growing season. A surplus of precipitation often results in muddy fields and a delay in planting and harvesting.

Table 1 gives data on temperature and precipitation for Jackson County, as recorded at Holton for the period 1941 to 1970. Table 2 shows probable dates of the first freeze in fall and last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 30.4 degrees F, and the average daily minimum is 19.7 degrees. The lowest temperature on record, which occurred at Holton in January 1915, is minus 22 degrees. In summer the average temperature is 76.0 degrees, and the average daily maximum is 87.8 degrees. The highest recorded temperature is 110 degrees, which occurred in August 1913. Temperature records were not kept at Holton during the 1930's, when most of the high temperature records in Kansas were set.

The annual precipitation is 35.28 inches. Of this annual total, 26.13 inches, or 74 percent, usually falls in April through September, which includes the growing season for most crops. In 2 years out of 10, the rainfall in April through September is less than 19.61 inches. The heaviest 1-day rainfall during the period of record was 8.37 inches at Holton on October 11, 1973.

Average annual snowfall is 20.9 inches. The greatest snow depth, which occurred during the winter of 1914-15, is 54 inches. On the average, 23 days per year have at least 1 inch of snow on the ground, but the snow rarely covers the ground for more than 7 days in succession.

The prevailing wind, recorded at nearby Topeka, is from the south. Average annual windspeed is 10 miles per hour; it is highest, 13 miles per hour, in March and April. The percent of possible sunshine averages 67 in summer and 52 in winter.

Tornadoes and severe thunderstorms occur occasionally in Jackson County. These storms are usually local in extent and of short duration so that the risk of damage is small. Hail falls during the warmer part of the year, but it is infrequent and of local extent. Crop damage by hail is less in this part of the State than it is in western Kansas.

Farming

Tall native prairie grasses originally covered most of Jackson County. Deciduous trees grew on the bottom land. In a few upland areas, mixed trees and native grasses were the original vegetation.

The main crops are corn, wheat, grain sorghum, soybeans, and, in a few areas, oats. Forage corn, forage sorghum, alfalfa, and bromegrass are also grown. In 1974, about 35,000 acres was in corn, 26,000 acres in wheat, 24,000 acres in grain sorghum, 16,000 acres in soybeans, and 4,000 acres in oats. These acreages fluctuate according to market prices. In 1974, there were 12,000 acres of alfalfa, 18,000 acres of wild hay, and 13,000 acres of pasture hay (*5*).

Beef cattle herds and hog farms are the main kinds of livestock enterprises. There are several dairy herds and a few sheep or chicken farms.

In 1948, the Jackson County Conservation District was organized. Its purpose is to promote soil and water conservation.

How this survey was made

Soil scientists made this survey to learn what kinds of soil are in the survey area, where they are, and how they can be used. The soil scientists went into the area knowing they likely would locate many soils they already knew something about and perhaps identify some they had never seen before. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; the kinds of rock; and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material, which has been changed very little by leaching or by the action of plant roots.

The soil scientists recorded the characteristics of the profiles they studied, and they compared those profiles with others in counties nearby and in places more distant. Thus, through correlation, they classified and named the soils according to nationwide, uniform procedures.

After a guide for classifying and naming the soils was worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, roads, and other details that help in drawing boundaries accurately. The soil map at the back of this publication was prepared from aerial photographs.

The areas shown on a soil map are called soil map units. Some map units are made up of one kind of soil, others are made up of two or more kinds of soil, and a few have little or no soil material at all. Map units are discussed in the sections "General soil map for broad land-use planning" and "Soil maps for detailed planning."

While a soil survey is in progress, samples of soils are taken as needed for laboratory measurements and for engineering tests. The soils are field tested, and interpretations of their behavior are modified as necessary during the course of the survey. New interpretations are added to meet local needs, mainly through field observations of different kinds of soil in different uses under different levels of management. Also, data are assembled from other sources, such as test results, records, field experience, and information available from state and local specialists. For example, data on crop yields under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it is readily available to different groups of users, among them farmers, managers of rangeland and woodland, engineers, planners, developers and builders, homebuyers, and those seeking recreation.

General soil map for broad land-use planning

The general soil map at the back of this publication shows, in color, map units that have a distinct pattern of soils and of relief and drainage. Each map unit is a unique natural landscape. Typically, a map unit consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one unit can occur in other units but in a different pattern.

The general soil map provides a broad perspective of the soils and landscapes in the survey area. It provides a basis for comparing the potential of large areas for general kinds of land use. Areas that are, for the most part, suited to certain kinds of farming or to other land uses can be identified on the map. Likewise, areas of soils having properties that are distinctly unfavorable for certain land uses can be located.

Because of its small scale, the map does not show the kind of soil at a specific site. Thus, it is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The kinds of soil in any one map unit differ from place to place in slope, depth, stoniness, drainage, or other characteristics that affect their management.

1. Kennebec-Zook-Wabash

Deep, nearly level, moderately well drained, poorly drained, and very poorly drained soils that have a silt loam or silty clay subsoil and formed in alluvium

This map unit is on the alluvial plains that are along the larger streams and are subject to flooding. It occupies about 6 percent of the county. It is about 31 percent Kennebec soils, 27 percent Zook soils, 24 percent Wabash soils, and 18 percent soils of minor extent (fig. 1).

The moderately well drained Kennebec soils are on the flood plains next to the streams. They are subject to flooding. They have a silt loam surface layer about 36 inches thick. The poorly drained Zook soils are on the low flood plains adjacent to foot slopes and bench escarpments away from the main stream channel. The upper part of the surface layer is silty clay loam. The lower part of the surface layer and the subsoil are silty clay. The very poorly drained Wabash soils are in backwater areas on flood plains. They are silty clay from the surface to a depth of 60 inches or more.

Of minor extent in this map unit are Chase, Reading, and Olmitz soils. Chase soils are somewhat poorly drained to moderately well drained, Olmitz soils are well drained and moderately well drained, and Reading soils are well drained. Chase and Olmitz soils are next to the uplands on benches or foot slopes and are nearly level and gently sloping. Reading soils are on high bottoms or terraces.

Most of the acreage is in cultivated farm crops. Some tracts are in trees or grass. Stream channels and adjacent areas are not arable, and most are wooded. The main concerns in managing these soils are flooding and the slow drainage in Wabash and Zook soils.

This map unit has good potential for cultivated farm crops, grassland, and woodland. Flooding is such a severe limitation and is so difficult to overcome that the potential for residential and other urban uses is poor. The potential for development of wetland wildlife habitat is good. Vegetables and other specialty crops are uniquely suited to this unit if a proper drainage system is installed and protection against flooding is provided.

2. Pawnee-Shelby-Burchard

Deep, gently sloping to steep, well drained and moderately well drained soils that have a clay or clay loam subsoil and formed in glacial material; on uplands

This map unit is on upland ridgetops and side slopes. It occupies about 40 percent of the county. It is about 42 percent Pawnee soils, 17 percent Shelby soils, 13 percent Burchard soils, and 28 percent soils of minor extent (fig. 2).

The well drained and moderately well drained, gently sloping to moderately sloping Pawnee soils are on ridgetops and the higher side slopes. They have a clay loam surface layer and a clay subsoil. The moderately well drained Shelby soils and well drained Burchard soils are on the lower side slopes. They have a clay loam surface layer and a clay loam subsoil. Shelby soils are moderately sloping to steep, and Burchard soils are strongly sloping to steep. In this survey area, Burchard soils are mapped only with Shelby soils.

Of minor extent in this map unit are the moderately well drained Kennebec soils and the moderately well drained and well drained Olmitz and Wymore soils. Olmitz soils are on foot slopes. Kennebec soils are on flood plains. Wymore soils are on the higher ridgetops.

Nearly all the acreage is in the cultivated crops commonly grown in the county. Many areas are in tame grass, and a few are in range or trees. Controlling erosion and maintaining tilth and fertility are concerns in managing these soils.

If erosion is controlled, this map unit has good potential for cultivated crops. It also has good potential for tame pasture and range. It has poor potential for woodland. The potential for residential and other urban uses is fair to poor because of the steep slopes and the content of clay.

3. Martin-Pawnee-Sogn

Deep and shallow, moderately well drained to somewhat excessively drained, gently sloping to steep soils that dominantly have a silty clay or clay subsoil and formed in residuum derived from shale, limestone, or glacial material; on uplands

This map unit is on upland ridgetops and side slopes. It occupies about 43 percent of the county. It is about 36 percent Martin soils, 27 percent Pawnee soils, 5 percent Sogn soils, and 32 percent soils of minor extent (fig. 3).

Martin soils are deep, are moderately well drained, and formed in material weathered from shale and clay beds. They are moderately sloping and strongly sloping and have a silty clay loam surface layer and a silty clay or silty clay loam subsoil. Pawnee soils are deep, are well drained and moderately well drained, and formed in glacial material. They are gently sloping and moderately sloping and have a clay loam surface layer and a clay subsoil. Sogn soils are shallow, are somewhat excessively drained, and formed in material weathered from limestone. They are moderately sloping to steep and have a silty clay loam surface layer. In this survey area, they are mapped only with Clime or Vinland soils.

Of minor extent in this map unit are the deep, somewhat poorly drained to moderately well drained Chase soils on benches or terraces next to the uplands; the moderately deep, moderately well drained Clime soils on upland side slopes; the deep, moderately well drained Kennebec soils on flood plains; the shallow, somewhat excessively drained Vinland soils on upland side slopes; and the deep, moderately well drained Wymore soils on upland ridgetops.

About 60 percent of the acreage is in cultivated field crops. The rest is mostly in pasture and range, but some areas along drainageways and some areas where slopes are steep support trees. Measures that control runoff and erosion and maintain tilth and fertility are needed.

This map unit has good potential for grasses and good to poor potential for cultivated farm crops. Because slopes are steep, the subsoil is clayey, and the soils are shallow, the unit has fair to poor potential for residential and other urban uses. It has good potential for openland and rangeland wildlife habitat.

4. Pawnee-Wymore

Deep, moderately well drained and well drained, gently sloping and moderately sloping soils that have a clay, silty clay, or silty clay loam subsoil and formed in glacial material and loess; on uplands

This map unit is on broad ridges that are higher than the surrounding areas. It occupies about 11 percent of the county. It is about 48 percent Pawnee soils, 37 percent Wymore soils, and 15 percent soils of minor extent (fig. 4).

Wymore soils generally are slightly higher in elevation than Pawnee soils. Both soils are gently sloping to moderately sloping and are moderately well drained and well drained. Pawnee soils have a clay loam surface layer and a clay subsoil. Wymore soils have a silty clay loam surface layer and a silty clay and silty clay loam subsoil.

Of minor extent in this map unit are the somewhat poorly drained and moderately well drained Chase soils, the well drained Burchard soils, and the moderately well drained Kennebec, Martin, and Shelby soils. Chase soils are on benches and terraces. Kennebec soils are on flood plains, and Burchard, Martin, and Shelby soils are on the lower side slopes in the uplands.

Most of the acreage is cropped, but some areas are in tame pasture or range. Measures that control erosion and maintain tilth and fertility are needed.

If the soils are properly protected, this map unit has good potential for cultivated farm crops, pasture, and range. The clayey subsoil is a severe limitation that is so difficult to overcome that the potential for residential and other urban uses is poor. The potential for development of openland and rangeland wildlife habitat is fair to good.

Soil maps for detailed planning

The map units shown on the detailed soil maps at the back of this publication represent the kinds of soil in the survey area. They are described in this section. The descriptions together with the soil maps can be useful in determining the potential of a soil and in managing it for food and fiber production; in planning land use and

developing soil resources; and in enhancing, protecting, and preserving the environment. More information for each map unit, or soil, is given in the section "Use and management of the soils."

Preceding the name of each map unit is the symbol that identifies the soil on the detailed soil maps. Each soil description includes general facts about the soil and a brief description of the soil profile. In each description, the principal hazards and limitations are indicated, and the management concerns and practices needed are discussed.

The map units on the detailed soil maps represent an area on the landscape made up mostly of the soil or soils for which the unit is named. Most of the delineations shown on the detailed soil map are phases of soil series.

Soils that have a profile that is almost alike make up a *soil series*. Except for allowable differences in texture of the surface layer or of the underlying substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement in the profile. A soil series commonly is named for a town or geographic feature near the place where a soil of that series was first observed and mapped. The Pawnee series, for example, was named for the town of Pawnee City in Pawnee County.

Soils of one series can differ in texture of the surface layer or in the underlying substratum and in slope, erosion, stoniness, salinity, wetness, or other characteristics that affect their use. On the basis of such differences, a soil series is divided into phases. The name of a *soil phase* commonly indicates a feature that affects use or management. For example, Pawnee clay loam, 1 to 3 percent slopes, is one of several phases within the Pawnee series.

Some map units are made up of two or more dominant kinds of soil. Such map units are called soil complexes.

A *soil complex* consists of areas of two or more soils that are so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area includes some of each of the two or more dominant soils, and the pattern and proportion are somewhat similar in all areas. Burchard-Shelby clay loams, 7 to 12 percent slopes, is an example.

Most map units include small, scattered areas of soils other than those that appear in the name of the map unit. Some of these soils have properties that differ substantially from those of the dominant soil or soils and thus could significantly affect use and management of the map unit. These soils are described in the description of each map unit. Some of the more unusual or strongly contrasting soils that are included are identified by a special symbol on the soil map.

Most mapped areas include places that have little or no soil material and support little or no vegetation. Such places are called *miscellaneous areas*; they are delineated on the soil map and given descriptive names. Pits, quarries, is an example. Areas too small to be delineated are identified by a special symbol on the soil map.

The acreage and proportionate extent of each map unit are given in table 4, and additional information on properties, limitations, capabilities, and potentials for many soil uses is given for each kind of soil in other tables in this survey. (See "Summary of tables.") Many of the terms used in describing soils are defined in the Glossary.

Ba—Burchard-Shelby clay loams, 7 to 12 percent slopes. These deep, strongly sloping, well drained and moderately well drained soils are on narrow ridges and side slopes along drainageways in the uplands. Areas are long and irregularly shaped. They are 40 to 50 percent Burchard soils and 35 to 45 percent Shelby soils. The two soils are so similar and so intricately mixed that it is not practical to separate them in mapping.

Typically, the Burchard soil has a surface layer of very dark brown clay loam about 8 inches thick and a subsurface layer of very dark grayish brown clay loam about 6 inches thick. The subsoil is dark yellowish brown, firm clay loam about 17 inches thick. Pockets and streaks of soft lime are below a depth of 26 inches. The underlying material to a depth of about 60 inches is brown clay loam with pockets and streaks of soft lime. In places soft lime is within a depth of 15 inches.

Typically, the Shelby soil has a surface layer of very dark brown clay loam about 15 inches thick. The subsoil is about 28 inches thick. The upper part is dark brown, friable clay loam; the lower part is brown, firm clay loam. Yellowish brown mottles are in the lower part. The underlying material to a depth of about 60 inches is yellowish brown clay loam with numerous accumulations of soft lime. In places the colors are redder. In some areas sand or gravel pockets are below a depth of 30 inches.

Included with these soils in mapping are small areas of Pawnee, Kennebec, and Olmitz soils. These included soils make up about 10 percent of the unit. The Pawnee soils are more clayey and the Kennebec soils less clayey than the Burchard and Shelby soils. The Pawnee soils are on ridgetops, and the Kennebec soils are along drainageways. The Olmitz soils have a thicker surface layer than the Burchard and Shelby soils. They are on concave foot slopes. In places numerous, scattered, large glacial boulders are on the surface.

Permeability in the Burchard and Shelby soils is moderately slow, runoff is rapid, and available water capacity is high. Reaction in the upper part of both soils is medium acid to neutral. It varies in the surface layer as a result of local liming practices. The Burchard soil is calcareous within 15 to 30 inches of the surface. Natural fertility in both soils is high, and organic-matter content is moderate. The surface layer can be easily tilled throughout a fairly wide range in moisture content. Both soils are erodible. The shrink-swell potential is moderate in the subsoil.

About half of the acreage is in the cultivated crops commonly grown in the county. The rest is mostly grassland. These soils have fair to good potential for cultivated crops and good potential for range, pasture, and hay. They have poor potential for most engineering uses, fair

potential for most recreation uses, and good to fair potential for openland and rangeland wildlife habitat.

These soils are suited to the crops commonly grown in the county. Water erosion is a severe hazard on these strongly sloping soils. Fertility, tilth, and organic-matter content can be maintained or improved by growing cover crops, applying barnyard manure, applying a proper amount of commercial fertilizer, and returning crop residue to the soil. Minimum tillage, terraces, grassed waterways, and contour farming help to protect the soil. Cultivated crops and tame grasses respond to needed applications of fertilizer and lime. In some areas slopes are so steep or irregular that terracing is not practical. In these areas minimum tillage and a cropping system that provides substantial plant cover are needed to control erosion.

These soils are well suited to pasture and range. Grasses help to control erosion. If the pasture or range is overgrazed, however, the soils are subject to erosion because of a poor plant cover and a less desirable plant community. An adequate plant cover helps to prevent excessive soil losses and improves moisture relationships. Proper stocking rates, uniform grazing distribution, deferment of grazing, and weed and brush control keep the grass and the soil in good condition. Potential pond reservoir sites are plentiful. If sand and gravel pockets are evident, however, the sand or gravel should be removed or bedded over with a clay layer or an alternative site should be selected.

These soils are well suited to windbreaks. Considerable care is needed if young trees are to grow well. Rainfall is likely to be limited and irregular. Cultivating young windbreaks to control weeds reduces the competition for soil moisture. Windbreaks should be protected from livestock, fire, and rodents.

The slope and the moderate shrink-swell potential moderately limit building site development. Special care is needed in the design and construction of houses to avoid the damage caused by shrinking and swelling and slope. Enlarging footings and foundations and adding steel reinforcement reduce the risk of damage caused by shrinking and swelling. If drain tiles that are surrounded by a sand or gravel envelope are installed around footings, the moisture level can be controlled and the damage caused by shrinking and swelling lessened. Buildings should be constructed in the less sloping areas. Consideration of the design and location of structures is needed in planning footings and foundations. Retaining walls or piers help to support footings and foundations. A plant cover is needed to control erosion on building sites.

The moderately slow absorption of effluent is a severe limitation if these soils are used as a septic tank absorption field. Other methods of sewage disposal, such as a sewage lagoon or a sanitary sewer, should be considered. Enlargement of the absorption field helps improve the functioning of septic tank systems. Onsite investigation is needed to determine whether or not sand or gravel pockets are in the soil. These pockets can cause the effluent to be inadequately filtered and to thus contaminate the ground water supply.

The slope is a severe limitation if these soils are used for sewage lagoons. Lagoons can be built in the less sloping areas or, if embankments are used, in the steeper areas. Sand or gravel pockets can cause seepage. They can be removed by excavation or sealed with impervious material. Capability subclass IIIe; Loamy Upland range site.

Bb—Burchard-Shelby clay loams, 7 to 12 percent slopes, eroded. These deep, strongly sloping, well drained and moderately well drained soils are on narrow ridges and along drainageways in the uplands. Areas are long and irregularly shaped. They are 40 to 50 percent Burchard soils and 35 to 45 percent Shelby soils. The two soils are so similar and so intricately mixed that it is not practical to separate them in mapping.

Typically, the Burchard soil has a surface layer of very dark brown and very dark grayish brown clay loam about 5 inches thick. The subsoil is dark yellowish brown, firm clay loam about 17 inches thick. Pockets and streaks of soft lime are between depths of 15 and 30 inches. The underlying material is brown clay loam with pockets and streaks of soft lime. In places the depth to lime is less than 15 inches. In areas where plowing has mixed the upper part of the subsoil with the surface soil, the surface layer is dark yellowish brown clay loam.

Typically, the Shelby soil has a surface layer of very dark brown clay loam about 5 inches thick. The subsoil is about 25 inches thick. The upper part is dark brown, friable clay loam; the lower part is brown, firm clay loam. Yellowish brown mottles are in the lower part. The underlying material is yellowish brown clay loam. In some areas sand or gravel pockets are below a depth of 30 inches, and in places the soil is redder. In areas where plowing has mixed the upper part of the subsoil with the surface layer, the surface layer is dark brown clay loam.

Included with these soils in mapping are small areas of Pawnee, Kennebec, and Olmitz soils and severely eroded spots. These included areas make up 20 to 25 percent of the unit. The Pawnee soils are more clayey and the Kennebec soils less clayey than the Burchard and Shelby soils. The Pawnee soils are on ridgetops, and the Kennebec soils are on flood plains in upland drainageways. The Olmitz soils have a thicker surface layer than the Burchard and Shelby soils. They are on the concave foot slopes next to the uplands. Numerous gullies or gully scars are in the severely eroded spots. In places numerous, scattered, large glacial boulders are on the surface.

Air and water move through the Burchard and Shelby soils at a moderately slow rate, and surface runoff is rapid. Available water capacity is high. Reaction varies in the surface layer as a result of local liming practices. It is medium acid to neutral in the upper part of both soils. The Burchard soil is calcareous at a depth of 15 to 30 inches. Natural fertility is medium in both soils, and organic-matter content is moderate. Tilth is fair. The soils

can crust or puddle after hard rains. Roots can be restricted somewhat by the compact clay loam subsoil. The shrink-swell potential is moderate in the subsoil.

Most of the acreage is used for cultivated crops, tame pasture, or hay. These soils have fair to good potential for crops, native range, tame pasture, and hay. They have fair potential for recreation uses and good to fair potential for openland and rangeland wildlife habitat. They have poor potential for most engineering uses.

In most areas these soils are suited to cultivated field crops, such as sorghum and small grain and legumes or grasses grown for hay. They are eroded and are subject to serious additional erosion damage. Minimizing tillage, growing cover crops, applying manure, applying a proper amount of commercial fertilizer, and returning crop residue to the soil help to control runoff, control further erosion, and improve fertility and tilth. Grassed waterways, terraces, and contour cultivation are needed to control erosion in cultivated fields. Cultivated crops and tame grasses respond well to applications of a proper amount of fertilizer and lime. In places slopes are so irregular and steep that terraces are not suited. In these areas minimum tillage and a cropping system that provides substantial plant cover are needed to control erosion.

These soils are well suited to tame pasture and native range. Grasses help to control erosion. If the pasture or range is overgrazed, however, the soils are susceptible to erosion damage because plant cover is poor and the plants are less desirable. Good management is needed to maintain a good plant cover, reduce the risk of erosion, and improve moisture relationships. Proper stocking rates, uniform distribution of grazing, and weed and brush control keep the grass and the soil in good condition. Potential pond reservoir sites are plentiful. If sand or gravel pockets are evident, however, the sand or gravel should be removed or bedded with a clay layer or an alternative site should be selected.

These soils are suited to windbreaks. Special care is needed if young trees are to grow well. Rainfall is sometimes limited and irregular, and applying additional water during dry periods promotes growth. Weeds and grasses can be controlled by cultivation or by other means. Windbreaks should be protected from livestock, fire, and rodents.

The slope and the moderate shrink-swell potential moderately limit building site development. Special care is needed in the design and construction of houses to prevent the damage caused by shrinking and swelling and slope. Enlarging footings and foundations and adding steel reinforcement reduce the risk of damage caused by shrinking and swelling. If drain tiles that are surrounded by a sand or gravel envelope are installed around footings, the moisture level can be controlled and shrinking and swelling lessened. Buildings should be constructed in the less sloping areas. Consideration of the design and location of structures is needed in planning footings and foundations. Retaining walls or piers help to support footings and foundations. A plant cover is needed to control erosion on building sites.

The moderately slow absorption of effluent is a severe limitation if these soils are used as a septic tank absorption field. Other methods, such as a lagoon or a sanitary sewer, should be considered. Enlargement of the absorption field helps improve the functioning of septic tank systems. Onsite investigation is needed to determine whether or not sand or gravel pockets are in the soil. These pockets can cause the effluent to be inadequately filtered and to thus contaminate the ground water supply.

The slope is a severe limitation if these soils are used for sewage lagoons. Lagoons can be built in the less sloping areas or, if embankments are used, in the steeper areas. Sand or gravel pockets can cause seepage. They can be removed by excavation or sealed with impervious material. Capability subclass IIIe; Loamy Upland range site.

Bc—Burchard-Shelby clay loams, 12 to 25 percent slopes. These deep, moderately steep and steep, well drained and moderately well drained soils are along drainageways in the uplands. Areas are irregularly shaped. They are 35 to 45 percent Burchard soils and 30 to 40 percent Shelby soils. The two soils are so similar and so intricately mixed that it is not practical to separate them in mapping.

Typically, the Burchard soil has a surface layer of very dark brown clay loam about 8 inches thick and a subsurface layer of very dark grayish brown clay loam about 6 inches thick. The subsoil is dark yellowish brown, firm clay loam about 17 inches thick. Streaks and pockets of soft lime are between depths of 15 and 30 inches. The underlying material to a depth of about 60 inches is yellowish brown and brown, calcareous clay loam. In places the depth to lime is less than 15 inches.

Typically, the Shelby soil has a surface layer of very dark brown clay loam about 15 inches thick. The subsoil is about 28 inches thick. The upper part is dark brown, friable clay loam; the lower part is brown, firm clay loam. The underlying material to a depth of about 60 inches is coarsely mottled, yellowish brown clay loam. In places the soil is redder. In some areas sand or gravel pockets are below a depth of 30 inches.

Included with these soils in mapping are small areas of Kennebec, Martin, Pawnee, and Olmitz soils and rock outcrop. These included areas make up 10 to 15 percent of the unit. The Kennebec soils are less clayey than the Burchard and Shelby soils. They are along upland drainageways. The Martin and Pawnee soils are less sloping than the Burchard and Shelby soils, are higher on the landscape, and contain more clay in the subsoil. The Olmitz soils are on concave foot slopes. They have a thicker surface layer than the Burchard and Shelby soils. The rock outcrop is in the steeper areas. In places numerous, scattered, large glacial boulders are on the surface.

Permeability is moderately slow in the Burchard and Shelby soils, and runoff is rapid. Available water capacity is high. The upper part of both soils is medium acid to neutral. The Burchard soil is calcareous at a depth of 15 to 30 inches. Natural fertility is high, and organic-matter

content is moderate. The clay loam subsoil somewhat restricts roots. The shrink-swell potential is moderate.

Most of the acreage is in range, pasture, or hay. These soils have good potential for those uses. They have poor potential for cultivated crops, fair to poor potential for recreational uses, and good to fair potential for openland and rangeland wildlife habitat. They have poor potential for most engineering uses.

These soils are well suited to pasture and range. A grass cover helps to control erosion, but the hazard of erosion is severe if the protective plant cover is removed. Good grass management and proper use are needed. Measures that control brush and weeds are needed. Tame grasses and legumes respond well to applications of a proper amount of fertilizer and lime. Pond sites are available. If sand or gravel pockets are evident, however, the sand or gravel should be removed or bedded with a clay layer or an alternative site should be selected.

These soils are suited to windbreaks. Considerable care of young trees is needed. Applying additional water during dry periods promotes growth. Controlling weeds and grasses conserves moisture. Windbreaks should be protected from livestock, fire, and rodents.

The slope and the moderate shrink-swell potential severely limit building site development. Special care in the design and construction of houses can prevent damage caused by shrinking and swelling and slope. Enlarging footings and foundations and adding steel reinforcement reduce the risk of damage caused by shrinking and swelling and help to support the weight of the structure. If drain tiles that are surrounded by a sand or gravel envelope are installed around footings, the moisture level can be controlled and shrinking and swelling lessened. Buildings should be constructed in the less sloping areas. Consideration of the design and location of structures is needed in planning footings and foundations. Retaining walls or piers help to support footings and foundations. A plant cover is needed to control erosion on building sites.

The moderately slow absorption of effluent and the steep slope are severe limitations if these soils are used as a septic tank absorption field. Other methods, such as a lagoon or a sanitary sewer, should be considered. Enlarging the absorption field and selecting a less sloping area improve the functioning of septic tank systems. Onsite investigation is needed to determine whether or not sand or gravel pockets are in the soil. These pockets can cause the effluent to be inadequately filtered and to thus contaminate the ground water supply.

The slope severely limits the use of these soils for sewage lagoons. Lagoons can be built in the less sloping areas or, if embankments are used, in the steeper areas. Sand or gravel pockets can cause seepage. They can be removed by excavation or sealed with impervious material. Capability subclass VIe; Loamy Upland range site.

Ca—Chase silty clay loam. This deep, nearly level, somewhat poorly drained to moderately well drained soil is on benches or terraces next to uplands. It is rarely flooded by stream overflow but is subject to flooding by water from the adjacent uplands. Areas are irregularly shaped.

Typically, the surface layer is black silty clay loam about 10 inches thick. The subsoil is about 35 inches thick. The upper part is black, friable silty clay loam; the lower part is very dark gray, mottled, firm silty clay. The underlying material to a depth of about 60 inches is dark gray mottled, silty clay. In places the subsoil is less clayey. Some areas are more sloping.

Included with this soil in mapping are small areas of the moderately well drained Kennebec and Martin soils and the well drained Olmitz and Reading soils. These soils make up 10 to 15 percent of the unit. The Kennebec, Olmitz, and Reading soils are less clayey than this Chase soil. The Kennebec soils are on flood plains, the Martin soils are on upland side slopes, and the Olmitz soils are on foot slopes adjacent to the uplands. The Reading soils and this Chase soil are in similar positions on the landscape.

Air and water move slowly through this soil. Surface runoff is slow. Available water capacity is high. Reaction ranges from medium acid to neutral in the upper part and is mildly alkaline below a depth of 40 inches. It varies in the upper part of the surface layer as a result of local farming and liming practices. Organic-matter content and natural fertility are high. The soil can be easily tilled. It tends to crust following heavy rains. The silty clay in the subsoil restricts roots. The subsoil is highly plastic and has a high shrink-swell potential.

Most areas are farmed. This soil has good potential for cultivated crops, range, pasture, hay, and trees. It has fair to poor potential for recreation uses, fair to good potential for most wildlife habitats, and poor potential for most engineering uses.

This soil is well suited to corn, sorghum, soybeans, and small grain and to legumes or grasses for hay. The chief management needs are maintaining or improving organic-matter content, fertility, and tilth. Also, the hazard of erosion is slight on long slopes. Minimizing tillage, returning crop residue to the soil, and applying barnyard manure and a proper amount of fertilizer maintain organic-matter content, fertility, and tilth. In some fields diversion terraces are needed to protect the soil against runoff from higher lying areas. In a few places contour farming, terraces, and grassed waterways are needed to help control water erosion.

This soil is well suited to native range, tame pasture, or hay. A grass cover helps to control erosion. Overgrazing can allow undesirable grasses, weeds, or brush to invade the grassed areas. Proper stocking rates, pasture rotation, timely deferment of grazing, and control of weeds and brush keep the grass and the soil in good condition. Yields of tame grasses can be increased by applying a proper amount of commercial fertilizer. Good pond sites are generally available.

This soil is well suited to trees. A few areas are woodland. Competing vegetation should be controlled or removed. The soil should not be compacted when wet.

Woodlands should be protected from grazing and fire, and thinning tree stands sometimes increases production.

This soil is poorly suited to building site development because it is subject to flooding and has a high shrink-swell potential. It is seasonably wet. Most of the floodwater is from adjacent uplands. A diversion terrace can divert water away from the building site. The soil is rarely flooded by stream overflow. In areas that are not flooded or are protected against flooding and are drained, it can be used as a building site if careful design and construction are used. If drain tiles that are surrounded by a sand or gravel envelope are installed around footings, wetness can be prevented and the variation in moisture levels, the shrinking and swelling, and the uplift pressure reduced. In places filling is needed to provide satisfactory surface drainage. Enlarging footings and foundations and providing extra reinforcement steel can prevent the cracking caused by shrink-swell expansion. Replacing the soil surrounding the foundation with material that shrinks and swells less than this soil also is beneficial. Shrinking and swelling can be reduced by insulating foundations and floors with an intervening layer of sand or gravel below the depth of seasonal expansion.

The slow absorption of effluent, the seasonal wetness, and the flooding severely limit the use of this soil as a septic tank absorption field. Other methods of disposal, such as a lagoon or a sanitary sewer, should be considered. A diversion terrace can divert water away from the site. Sites subject to flooding from stream overflow should be avoided unless they can be protected. Installing perimeter drains or enlarging the absorption field improves the functioning of septic tank systems.

The flooding severely limits the use of this soil for sewage lagoons. In areas where water is diverted and the soil is protected against flooding or is not flooded, sewage lagoons are suitable. Capability subclass IIw; Loamy Lowland range site.

Cb—Clime-Sogn complex, 5 to 20 percent slopes. This map unit consists of moderately deep and shallow, moderately sloping to steep, moderately well drained and somewhat excessively drained soils on side slopes and knolls in the uplands. Areas are irregularly shaped. They are 40 to 50 percent Clime soils and 25 to 35 percent Sogn soils.

The Clime and Sogn soils occur as alternating narrow areas on hillsides. The Sogn soils are in the less sloping areas above areas of resistant limestone. The Clime soils are in the steeper areas between the limestone layers. The two soils are so intricately mixed or are in areas so small that it is not practical to separate them in mapping.

Typically, the Clime soil has a surface layer of black silty clay about 9 inches thick. The subsoil is dark grayish brown, very firm silty clay about 13 inches thick. The underlying material is grayish brown silty clay. Calcareous clayey shale is at a depth of 35 inches. In places the depth to shale is less than 20 inches. In some areas the surface layer is silty clay loam.

Typically, the Sogn soil has a surface layer of black silty clay loam about 12 inches thick. Limestone is at a depth of 12 inches. In places the surface layer is silty clay.

Included with these soils in mapping are small areas of Martin and Pawnee soils and shale and other rock outcrop. These included areas make up 10 to 20 percent of the unit. The Martin and Pawnee soils are intermingled with the Clime and Sogn soils in narrow areas above, between, or below the limestone layers. They have a less clayey surface layer than the Clime and Sogn soils and are deeper than 40 inches.

Permeability is slow in the Clime soil and moderate in the Sogn soil. Available water capacity is low in the Clime soil and very low in the Sogn soil. Runoff is rapid to excessive. Reaction is mildly alkaline or moderately alkaline throughout both soils. Organic-matter content is low to moderate in the Clime soil and low in the Sogn soil. Except for shallow or rocky areas, natural fertility is high. The shrink-swell potential is moderate.

Most areas are in native grass. A few are cultivated or are in tame grass. These soils have poor potential for cultivated crops. They have good potential for native grass and have fair potential for tame grass. The potential for recreation uses is fair to poor, and the potential for openland and rangeland wildlife habitat is fair. The potential for most engineering uses is poor.

Most areas are not suitable for cultivation. Small areas, mostly of Clime soil, where slopes are less than about 8 percent can be cultivated if proper conservation measures are applied, but these areas are intermingled with areas of steeper shallow soils and are generally so small that cultivation is not practical. They are generally cultivated only if they are adjacent to other cultivated fields. The erosion hazard is severe if the plant cover is removed.

These soils are suited to range and pasture. A cover of permanent vegetation helps to control erosion. In the steeper areas, maintaining the pasture and harvesting hay are difficult. Proper stocking rates, rotation of range or pasture, deferment of grazing, and control of weeds and brush are needed to maintain a good grass cover that protects the soils against erosion and maintains good grass production. Applications of a proper amount of commercial fertilizer, as determined by soil tests, are needed if tame grasses are grown. Good pond sites are limited because of the depth to shale or rock.

The Clime soil is suited to windbreaks, whereas the Sogn soil is not suited. Special care is needed when the trees are planted and when they are young. Weed control conserves moisture. Applying water during dry periods promotes growth. Windbreaks should be protected from livestock, fire, and rodents.

If slopes are less than 15 percent, the Clime soil is moderately limited as a building site because of low strength, the moderate shrink-swell potential, and the slope. It is severely limited in areas where slopes are more than 15 percent. The shallowness of the Sogn soil is a severe limitation. Onsite investigation is needed to

locate the less sloping areas of deeper soil. The risk of damage caused by shrinking and swelling can be reduced by proper design and construction. Enlarging footings and foundations and adding extra reinforcement steel provide more strength. If tile drains that are surrounded by sand or gravel are installed around footings, variations in moisture levels and shrinking and swelling can be reduced. In some cases the entire basement floor can be reinforced so that it acts as a foundation. Retaining walls and piers can help to support footings and buildings. Plant cover is needed to control erosion around the building.

The limited depth, the slow absorption of effluent, and the slope severely limit the use of these soils as a septic tank absorption field. Onsite investigation is needed to locate deeper soils in less sloping areas. Other methods of waste disposal, such as a community sanitary sewer, should be considered. Enlargement of the absorption fields improves the functioning of septic tank systems.

The limited depth and the slope severely limit the use of these soils for sewage lagoons. Diverting sewage to areas more suitable for disposal should be considered. Capability subclass VIe; Clime soil in Limy Upland range site, Sogn soil in Shallow Limy range site.

Ka—Kennebec silt loam. This deep, nearly level, moderately well drained soil is on flood plains, typically near stream channels or old meander scars in stream valleys and less commonly on the lower part of upland drainageways. It is subject to occasional flooding. Individual areas are long, continuous, and irregularly shaped. They are more than 500 feet wide and range from 5 to several hundred acres in size.

Typically, the surface layer is very dark brown silt loam about 6 inches thick. The subsurface layer is very dark brown silt loam about 28 inches thick. The next layer is very dark grayish brown, friable silt loam about 14 inches thick. The underlying material to a depth of about 60 inches is dark grayish brown silt loam. In some areas the soil is calcareous at the surface. In places silty clay loam is below a depth of 20 inches.

Included with this soil in mapping are small areas of Wabash and Zook soils and some stream channels. The Wabash and Zook soils are darker colored and more clayey than this Kennebec soil. They are in swales or backwater areas. The stream channels, which are less than 100 feet wide, dissect areas of the Kennebec soil. Included areas make up about 10 percent of the unit.

Air and water move through this soil at a moderate rate. Surface runoff is slow. Available water capacity is very high. The soil is dominantly slightly acid or neutral. In places it is calcareous. It is friable and can be easily tilled. Natural fertility and organic-matter content are high. Roots are generally not restricted. The water table is sometimes at a depth of 30 inches during rainy periods. The shrink-swell potential is moderate.

Most areas are farmed. This soil has good potential for cultivated crops, range, hay, pasture, and trees. It has fair potential for most engineering uses, fair to good potential for recreation uses, and good potential for openland and woodland wildlife habitat.

This soil is suited to corn, sorghum, and small grain and to grasses and legumes grown for hay or pasture. Row crops can be grown year after year if all crop residue is returned to the soil and a proper amount of fertilizer is applied. Minimizing tillage, planting cover crops, returning crop residue to the soil, and applying barnyard manure and a proper amount of commercial fertilizer improve fertility and organic-matter content, reduce crusting, increase the rate of water infiltration, and protect the soil against scouring.

This soil can be used for range, pasture, or hay. Proper stocking rates, pasture or range rotation, timely deferment of grazing, and weed and brush control keep the grass and the soil in good condition. Good pond sites are limited because of seepage, flooding, low strength, and a high content of humus.

This soil is well suited to woodland. Control or removal of competing vegetation is needed. Protection from livestock, fire, and rodents also is needed. Production can be increased by thinning the stands and by selective cutting.

Flooding and seasonal wetness severely limit building site development. In areas that are not flooded or are protected against flooding and are drained, the moderate shrink-swell potential and low strength are moderate limitations. Constructing dikes and filling provide protection against flooding. Tile drains surrounded by a sand or gravel envelope reduce wetness and stabilize shrink-swell pressure. Enlargement of footings and foundations and additions of extra steel reinforcements also reduce shrink-swell damage. Surface water can be diverted away from the building site. In some cases the entire basement floor can be reinforced so that it acts as a foundation.

This soil has severe limitations for septic tank absorption fields and sewage lagoons because of the flooding and the wetness. Other methods of sewage disposal, such as a sewage lagoon or a community sanitary sewer, should be considered. Protecting against flooding and installing perimeter drains around the absorption field improve the functioning of septic tank systems. Sewage lagoons function properly in areas that are not flooded or are protected against flooding. This soil is a good source of topsoil. Capability subclass IIw; Loamy Lowland range site.

Kb—Kennebec soils. These deep, nearly level and gently sloping, moderately well drained soils are on flood plains in upland drainageways that are cut by a narrow channel. Flooding is occasional to frequent. Individual areas are typically narrow but are continuous, and they are irregularly shaped. They are 300 to 1,000 feet wide and are about 3 to 200 acres.

Typically, the surface layer is very dark brown and very dark grayish brown. It is about 40 inches thick. The upper 20 inches is silt loam, loam, clay loam, or silty clay loam, and the lower 20 inches is silt loam or silty clay loam. The underlying material to a depth of about 60

inches is brown silty clay loam. In some places the soil has free carbonates throughout. In others it contains more sand and less silt throughout.

Included with these soils in mapping are small areas of Burchard, Chase, and Shelby soils and stream channels. These included areas make up about 12 percent of the unit. The Burchard and Shelby soils are on sloping uplands, and the Chase soils are on terraces and benches. All three have a more clayey subsoil than these Kennebec soils. The meandering drainage channels, which are less than 100 feet wide, dissect this map unit.

Water and air move through these soils at a moderate rate. Surface runoff is slow to medium. Available water capacity is very high. Reaction ranges from medium acid to neutral. Natural fertility and organic-matter content vary according to the soil material and the overwash. The surface layer is friable and can be easily tilled. Roots are generally not restricted. The water table is at a depth of about 30 inches during some rainy periods. The shrink-swell potential is moderate.

Most areas are farmed. These soils have good potential for cultivated crops, hay, pasture, range, and trees. They have fair to poor potential for recreation and engineering uses and good potential for openland and woodland wildlife habitat.

These soils are suited to corn, sorghum, and small grain and to grasses and legumes grown for hay or pasture. Minimizing tillage, planting cover crops, and returning crop residue to the soil or regularly adding organic material improve fertility, reduce crusting, and increase the rate of water infiltration. In the areas next to the uplands, terraces or diversions that empty into grassed waterways protect the soil against runoff from higher side slopes.

These soils can be used for range, pasture, and hay. Proper stocking rates, pasture or range rotation, timely deferment of grazing, and weed or brush control keep the grass and the soil in good condition. Good pond sites are generally available.

These soils are well suited to woodland, and a few acres are wooded. The yield potential is good. The moderate hazard of plant competition can be overcome by controlling or removing competing vegetation. Protection from livestock, rodents, and fire is needed. Selective cuttings improve production.

The flooding and the seasonal wetness severely limit building site development. In areas that are not flooded or are protected against flooding and are drained, the moderate shrink-swell potential and low strength are moderate limitations. Constructing dikes or filling provides protection against flooding. Installing tile drains that are surrounded by sand or gravel reduce wetness and stabilize shrink-swell pressure. Enlarging footings and foundations and adding extra steel reinforcements also reduce shrink-swell damage. Surface water can be diverted away from the building site. In some cases the entire floor can be reinforced so that it acts as a foundation.

These soils have severe limitations for septic tank absorption fields and sewage lagoons because of the flooding and the wetness. Other methods of sewage disposal, such as a sewage lagoon or a community sanitary sewer, should be considered. Protecting the areas against flooding and installing perimeter drains around the absorption field improve the functioning of septic tank systems. Sewage lagoons work well in areas that are not flooded or are protected against flooding. This soil is a good source of topsoil. Capability subclass IIw; Loamy Lowland range site.

Kc—Kennebec soils, channeled. These deep, nearly level and gently sloping, moderately well drained soils are on narrow flood plains in upland drainageways that are cut by meandering stream channels. Flooding is frequent. Individual areas are typically narrow but are continuous, and they range in width from about 200 to 400 feet.

Typically the surface layer is very dark brown and very dark grayish brown. It is about 40 inches thick. The upper 20 inches is silt loam, loam, clay loam, or silty clay loam, and the lower 20 inches is silt loam or silty clay loam. The underlying material to a depth of about 60 inches is brown silty clay loam. In some places the soil is moderately alkaline and calcareous throughout. In others it is stratified throughout with thin layers of sandy or clayey material.

Included with these soils in mapping are small areas of Chase, Martin, Pawnee, and Zook soils. These soils make up 10 to 20 percent of the unit. They are more clayey than the Kennebec soils. The Chase soils are on terraces and benches, whereas Zook and Kennebec soils occupy similar positions on the landscape. Martin and Pawnee soils are on the lower side slopes and foot slopes in the uplands.

Permeability is moderate in the Kennebec soils. Surface runoff is medium to slow. The soils are wet much of the time. They have a high available water capacity and readily release water to plants. The water table is at a depth of about 30 inches during some rainy periods . Siltation and scouring are hazards. Reaction, natural fertility, and organic-matter content vary. The shrink-swell potential is moderate.

Most areas are in grass. These soils have good potential for range, pasture, and woodland. They have poor potential for crops and for most engineering uses. They have good potential for openland and woodland wildlife habitat. Ponds and grassed waterways for terrace outlets are in many areas.

Most areas are not suited to cultivated crops because they are cut by meandering channels, are frequently flooded, and have small, inaccessible fields and some steep slopes. Farmed areas are those that are adjacent to other cultivated fields. If areas are cultivated, minimizing tillage, planting cover crops, and returning crop residue to the soil or adding organic material improve fertility, reduce crusting, increase the rate of water infiltration, and reduce scouring. Applications of a proper amount of commercial fertilizer benefit cultivated crops and tame grasses.

These soils can be used for native range, tame pasture, or hay. Proper stocking rates, pasture or range rotation, timely deferment of grazing, a timely season of use, and weed or brush control keep the soil and the grass in good condition.

These soils are suited to trees, but only a small acreage is wooded. Protection from grazing is needed. The yields of wood crops can be increased by thinning stands, by selectively cutting, and by preventing fires. Control or removal of competing vegetation is needed.

The frequent flooding and the seasonal wetness severely limit building site development. In areas that are not flooded or are protected against flooding and are drained, the moderate shrink-swell potential and low strength are moderate limitations. Constructing dikes or filling can protect the building site against flooding. Seasonally wet sites should be avoided unless drainage can be provided. Installing tile drains around footings and surrounding the drains with sand or gravel stabilize moisture levels and shrink-swell damage. Enlarging footings and foundations and adding extra steel reinforcement also reduce shrink-swell damage. Surface water can be diverted away from the building site. In some cases the entire floor can be reinforced so that it acts as a foundation.

These soils have severe limitations for septic tank absorption fields and sewage lagoons because of the flooding and the wetness. Other methods of sewage disposal, such as a community sanitary sewer, should be considered. Sewage lagoons work well in areas that are not flooded or are protected against flooding. Capability subclass VIw; Loamy Lowland range site.

Ma—Martin silty clay loam, 3 to 8 percent slopes. This deep, moderately sloping, moderately well drained soil is on ridgetops and side slopes in the uplands. Individual areas are irregularly shaped.

Typically, the surface layer is black silty clay loam about 11 inches thick. The subsoil is about 49 inches thick. The upper part is very dark gray, friable silty clay loam; the lower part is very dark grayish brown, firm silty clay and dark grayish brown, very firm silty clay. In some places, the subsoil is thinner and the depth to shale is less than 40 inches. In others the subsoil is not so dark and is less clayey in the lower part. In some areas it is reddish brown.

Included with this soil in mapping are small areas of Clime, Pawnee, Sogn, and Vinland soils. These soils make up about 10 percent of the unit. The Pawnee soils formed in glacial till. They are in a slightly higher position on the landscape than the Martin soil. The Clime soils are less than 40 inches deep over shale. They are in sloping, convex areas. The Sogn and Vinland soils are less than 20 inches deep over limestone and shale. They occur as narrow areas on convex slopes.

Water and air move through this soil at a slow rate, and surface runoff is rapid. Available water capacity is high. Reaction is generally medium acid in the surface layer and medium acid to neutral in the subsoil. It varies in the surface layer as a result of local liming practices. Natural fertility is high, and organic-matter content is moderate. This soil is erodible. The surface layer is friable and can be easily tilled. It tends to crust or puddle after hard rains. Roots are restricted by the silty clay subsoil. The shrink-swell potential is high.

Most areas are farmed. Some are in range or pasture. This soil has good potential for cultivated crops, hay, pasture, and range. It has fair potential for recreation uses and poor potential for most engineering uses. It has good potential for openland and rangeland wildlife habitat.

This soil is suited to sorghum (fig. 5), soybeans, and small grain and to grasses and legumes grown for hay and pasture. Corn is not so well suited as some other crops. If the soil is used for cultivated crops, minimum tillage and cover crops maintain fertility and tilth, prevent excessive soil loss, and increase the rate of water infiltration. Grassed waterways, terraces, and contour farming help to control erosion (fig. 6). Returning crop residue to the soil and regularly adding commercial fertilizer and lime improve fertility and reduce crusting.

The use of this soil for native range, tame pasture, or hay is also effective in controlling erosion. If the pasture or range is overgrazed, erosion can occur and undesirable grasses, weeds, or brush can invade. Proper stocking rates, pasture rotation, timely deferment of grazing, and control of weeds and brush keep the grass and the soil in good condition. Pond sites are available.

This soil is suited to windbreaks. Considerable care is needed if young trees are to grow well. Rainfall is likely to be limited and irregular, and applying additional water promotes growth during dry periods. Cultivating windbreaks controls and conserves soil moisture. Protection from livestock, fire, and rodents is needed.

The high shrink-swell potential and low strength severely limit building site development. The harmful effects of shrinking and swelling and low strength can be overcome by careful design and proper construction. Enlarging footings and foundations and adding extra reinforcement steel can prevent cracking. Installing a drain tile surrounded by sand or gravel reduces the variation in moisture levels, shrinking and swelling, and uplift pressure. Replacement of soil surrounding the foundation with soil material that shrinks and swells less than this soil is also beneficial. Shrink-swell expansion can be reduced by insulating foundations and floors with an intervening layer of sand or gravel below the depth of seasonal expansion. In some cases the entire basement floor can be reinforced so that it acts as a foundation. Diverting surface water or filling low areas provides good drainage. Buildings should be constructed in the less sloping areas. Consideration of the design and location of structures is needed in planning footings and foundations. Retaining walls or piers help to support footings and foundations. A plant cover is needed to control erosion around buildings.

The slow absorption of effluent severely limits the use of this soil as a septic tank absorption field. Other methods of sewage disposal, such as a sewage lagoon or a

community sanitary sewer, should be considered. Increasing the size of the absorption field and installing perimeter drains around the absorption field improve the functioning of septic tank systems.

The slope is a moderate limitation if this soil is used for sewage lagoons. Onsite investigation is needed to locate the less sloping areas. Small lagoons can be constructed in some of the more sloping areas if embankments are used. Sewage can be diverted to somewhat distant areas that are better suited to lagoons or septic tank absorption fields. Capability subclass IIIe; Loamy Upland range site.

Mb—Martin silty clay loam, 3 to 8 percent slopes, eroded. This deep, moderately sloping, moderately eroded, moderately well drained soil is on ridgetops and side slopes in the uplands. Individual areas are irregular in shape.

Typically, the surface layer is black or very dark gray silty clay loam about 5 inches thick. The subsoil is about 43 inches thick. It is very dark gray, firm silty clay in the upper part and very dark grayish brown, firm silty clay and dark grayish brown, very firm silty clay in the lower part. In places, the subsoil is thinner and shale is within a depth of 40 inches. In some areas the subsoil is reddish brown. In some small areas the surface layer is thicker. Numerous gullies or gully scars are evident.

Included with this soil in mapping are small areas of Clime, Pawnee, Sogn, and Vinland soils. These soils make up about 12 percent of the unit. The Pawnee soils formed in glacial till. They are slightly higher on the landscape than this Martin soil. The Clime soils are less than 40 inches deep over shale. They are in sloping, convex areas. The Sogn and Vinland soils are less than 20 inches deep over limestone and shale. They occur as narrow areas on convex slopes.

Permeability is slow. Surface runoff is rapid. Available water capacity is high. Reaction in the surface layer is generally medium acid, but it varies as a result of local liming practices. The subsoil is medium acid to neutral. Natural fertility is medium, and organic-matter content is moderately low. The surface layer is firm. It tends to crust or puddle after hard rains. Tilth is poor. The silty clay subsoil restricts roots. The shrink-swell potential is high.

Most areas are farmed. Some are in tame pasture. A few have been reseeded to native range. This soil has fair potential for cultivated crops, hay, and pasture and good potential for range. It has poor potential for most engineering uses and fair potential for recreation uses. It has good potential for openland and rangeland wildlife habitat.

This soil is suited to small grain and sorghum and to grasses and legumes. Corn is not so well suited as some other crops. Control of runoff and improvement of fertility and tilth are needed. Also, the soil is moderately eroded and is subject to additional erosion damage. Minimum tillage and cover crops maintain fertility and tilth, protect the soil against additional erosion, and increase the rate of water infiltration. Grassed waterways, terraces, and contour farming are needed in cultivated fields. Tame grasses can be grown in grassed waterways. Cultivated crops and tame grasses respond to applications of fertilizer, lime, and barnyard manure, which improve fertility and tilth and reduce crusting.

Erosion can be controlled by using this soil for range, pasture, or hay. As a result of improper use of the range, however, further erosion damage can occur and undesirable plants can invade. Proper stocking rates, pasture rotation, timely deferment of grazing, and control of weeds and brush are needed to keep the grass cover and the soil in good condition. Pond sites are available.

This soil is suited to windbreaks. Considerable care of young plantings is needed. Watering during dry periods promotes growth. It is needed because rainfall is likely to be limited and irregular. Cultivation or other means are needed to control competing vegetation. Windbreaks should be protected from livestock, fire, and rodents.

The high shrink-swell potential and low strength severely limit building site development. The harmful effects of shrinking and swelling and low strength can be overcome by careful design and proper construction. Enlarging footings and foundations and adding extra reinforcement steel can prevent cracking. Installing a drain tile surrounded by sand or gravel reduces the variation in moisture, shrinking and swelling, and uplift pressure. Replacement of the soil surrounding the foundation with soil material that shrinks and swells less than this soil also is beneficial. Shrink-swell expansion can be reduced by insulating foundations and floors with an intervening layer of sand or gravel below the depth of seasonal expansion. In some cases the entire basement floor can be reinforced so that it acts as a foundation. Good drainage can be provided by diverting surface water or by filling low areas. Buildings should be constructed in the less sloping areas. Consideration of the design and location of structures is needed in planning footings and foundations. Retaining walls help to support footings and foundations. A plant cover is needed to control erosion around buildings.

The slow absorption of effluent severely limits the use of this soil as a septic tank absorption field. Other methods of sewage disposal, such as a sewage lagoon or a community sanitary sewer, should be considered. Increasing the size of the absorption field and installing perimeter drains around the absorption field improve the functioning of septic tank systems.

The slope is a moderate limitation if this soil is used for sewage lagoons. Onsite investigation is needed to locate the less sloping areas. Small lagoons can be constructed in some of the more sloping areas if embankments are used. Sewage can be diverted to somewhat distant areas that are better suited to lagoons or septic tank absorption fields. Capability subclass IVe; Clay Upland range site.

Mc—Martin-Vinland silty clay loams, 5 to 10 percent slopes. This map unit consists of deep and shallow, moderately sloping to strongly sloping, moderately well drained and somewhat excessively drained soils on upland

ridges and side slopes. It is dissected by drainageways. Areas are irregularly shaped. They are 40 to 50 percent Martin soils and 35 to 45 percent Vinland soils. The two soils are so intricately mixed and occur as such narrow bands that it is not practical to separate them in mapping. In places the surface layer has been thinned by erosion, and many cultivated fields have numerous scattered shale and other rock fragments on the surface.

Typically, the Martin soil has a surface layer of black silty clay loam about 11 inches thick. The subsoil is about 49 inches thick. The upper part is very dark gray, friable silty clay loam; the lower part is very dark grayish brown, very firm silty clay. In places, the subsoil is thinner and shale is within 40 inches of the surface. In some areas the subsoil is reddish brown.

Typically, the Vinland soil has a surface layer of very dark grayish brown silty clay loam about 5 inches thick. The subsoil is very dark brown, firm silty clay loam about 6 inches thick. The underlying material is mixed grayish brown and dark brown silty clay loam over weathered silty and sandy shale, which is at a depth of about 17 inches. In places the depth to shale is more than 20 inches.

Included with these soils in mapping are small areas of Clime, Pawnee, and Sogn soils and limestone or shale outcrop. These soils make up about 15 percent of the unit. The Pawnee soils formed in glacial till. They are slightly higher on the landscape than the Martin and Vinland soils. The Sogn soils are shallow over limestone. They are in the less sloping areas. The Clime soils are 20 to 40 inches deep over calcareous clayey shale and have a more clayey surface layer than the Martin and Vinland soils. The limestone or shale outcrop is in some of the steeper areas.

Permeability is slow in the Martin soil and moderate in the Vinland soil. Runoff is rapid. Available water capacity is high in the Martin soil and low in the Vinland soil. Natural fertility is medium or high in both soils, and organic-matter content is low to moderate. Reaction is medium acid to neutral. The Martin soil has a firm silty clay subsoil that releases water slowly to plants. The shrink-swell potential is moderate in the Vinland soil and high in the Martin soil.

About half of the acreage is cultivated. Many areas are in tame grass pasture or native grass range. These soils have good potential for range and pasture and fair potential for farming. They have good to fair potential for rangeland wildlife habitat and fair to poor potential for most engineering uses.

These soils are suited to sorghum and small grain and to legumes and grasses grown for hay and pasture. If cultivated, they are erodible. Minimum tillage, cover crops, grassed waterways, terraces, and contour farming in cultivated fields help to prevent excessive soil loss. Returning crop residue to the soil and adding manure or commercial fertilizer reduce crusting and increase the rate of water infiltration.

The use of these soils for range, pasture, or hay is effective in controlling erosion. Overgrazing can reduce the plant cover and thus result in erosion damage and can increase the less desirable grasses, weeds, or brush. Proper stocking rates, pasture or range rotation, timely deferment of grazing, and weed and brush control keep the grass and the soil in good condition. Tame grass responds well to commercial fertilizer and lime applied according to soil tests. Ponds should be constructed on the Martin soil.

The Martin soil is suited to windbreaks, and the Vinland soil is unsuited. If possible, therefore, windbreaks should be planted on the Martin soil. Considerable care of young trees is needed. During dry periods, applications of extra water are needed to promote early growth. Control of competition from other plants is needed. Windbreaks should be protected from livestock, fire, and rodents.

The Martin soil has severe limitations for building sites because of the high shrink-swell potential and low strength. The Vinland soil has a moderate limitation because it is shallow over shale. The harmful effects of these limitations can be overcome by careful design and proper construction. Onsite investigation is needed to select the less sloping areas and to determine the specific soil limitations. Enlarging footings, foundations, and floors and adding extra reinforcement steel can prevent the cracking caused by shrink-swell expansion. Installing a drain tile surrounded by sand or gravel reduces the variation in moisture levels, shrinking and swelling, and uplift pressure. Replacement of the soil surrounding the foundation with soil material that shrinks and swells less also is beneficial. Shrink-swell expansion can be reduced by insulating foundations and floors with an intervening layer of sand and gravel below the depth of seasonal expansion. In some cases the entire basement floor can be reinforced so that it acts as a foundation. Retaining walls or piers help to support footings and foundations. Buildings should be constructed in the less sloping areas. Consideration of the design and location of structures is needed in planning footings and foundations. A plant cover is needed to control erosion on the building site.

These soils have severe limitations for septic tank absorption fields. The Martin soil absorbs effluent slowly, and the Vinland soil is less than 20 inches deep over shale. Other methods of waste disposal, such as a sewage lagoon or a community sanitary sewer, should be considered. Increasing the size of the absorption field and installing perimeter drains around the field improve the functioning of septic tank systems.

The slope of both soils and the limited depth to shale in the Vinland soil are severe limitations if these soils are used for sewage lagoons. Onsite investigation is needed to locate areas where the deeper Martin soil is less sloping. Small lagoons can be built in some of the steeper areas if embankments are used. Elevating a dwelling or a disposal area can provide sufficient depth. Sewage can be diverted to areas that are more suitable for disposal. Capability subclass IVe; Loamy Upland range site.

Oa—Olmitz clay loam, 2 to 5 percent slopes. This deep, gently sloping to moderately sloping, well drained to moderately well drained soil is on alluvial-colluvial fans at the mouth of upland drainageways and on concave foot slopes at the base of uplands. It is subject to rare flooding by water from adjoining uplands. Areas are irregularly shaped.

Typically, the surface layer is very dark brown clay loam about 24 inches thick. The subsurface layer is very dark brown clay loam about 8 inches thick. The subsoil is dark brown, friable clay loam and brown, firm clay loam more than 28 inches thick. In places 12 to 18 inches of recent deposit is on the surface. In some areas the upper part of the surface layer is stratified with soil material that is grayer and more silty. In other areas carbonates are below a depth of 40 inches.

Included with this soil in mapping are small areas of Burchard, Chase, Kennebec, Reading, and Shelby soils. These soils make up about 15 percent of the unit. The Chase and Reading soils have a more clayey subsoil than this Olmitz soil. They are on benches or high bottoms below this Olmitz soil. The Burchard and Shelby soils have a thinner surface layer than the Olmitz soil. They are in the steeper areas next to uplands. The Kennebec soils are less sandy than the Olmitz soil. They are on flood plains along upland drainageways.

Water and air move through this soil at a moderate or moderately slow rate. Surface runoff is medium to rapid. Available water capacity is high. Reaction is strongly acid to neutral. Organic-matter content is moderate, and natural fertility is high. The soil can be easily tilled, but it can crust after heavy rains. The shrink-swell potential is moderate. The soil is subject to additional deposition from eroding fields in steeper areas.

Most areas are farmed. This soil has good potential for cultivated crops, range, pasture, and hay. It has fair to good potential for recreation uses and good potential for openland, woodland, and rangeland wildlife habitat. It has fair potential for most engineering uses.

This soil is suited to corn, sorghum, soybeans, and small grain and to legumes and grasses grown for hay or pasture. The major needs are maintaining or improving organic-matter content, fertility, and tilth. Erosion is a hazard on long slopes, and erosion control is needed in some areas. Minimizing tillage, returning crop residue to the soil, and applying barnyard manure and a proper amount of commercial fertilizer maintain and improve organic-matter content, fertility, and tilth. In some areas diversion terraces are needed to protect the soil against runoff from higher lying areas. Contour farming, terraces, and grassed waterways are needed to control water erosion in some areas.

This soil is well suited to range, pasture, and hay. A few areas are in grasses. Proper use and desirable grasses keep the range or pasture and the soil in good condition and help to control erosion. Yields of tame grasses can be increased by applying a proper amount of fertilizer.

This soil is well suited to windbreaks. Considerable care of young plantings is needed. During dry periods applications of extra water are needed to promote early growth. Controlling competing vegetation and protecting the windbreak from grazing, fire, or rodents are management needs.

The shrink-swell potential moderately limits building site development. Some areas receive additional water from higher upland slopes. A diversion terrace can be used to divert this excess surface water from the building site. The risk of damage caused by shrinking and swelling can be reduced by proper design and construction, for example, by insulating footings, floors, and foundations with an intervening layer of sand or gravel below the depth of seasonal expansion. Enlarging the footings and foundations and adding reinforcement steel help to prevent cracking. Installing tile drains surrounded by a sand or gravel envelope reduces variation in moisture levels and shrinking and swelling.

The moderately slow absorption of effluent is a moderate limitation if this soil is used as a septic tank absorption field. Another method of sewage disposal, such as a community sanitary sewer system, should be considered. Increasing the size of the absorption field improves the functioning of septic tank systems.

The slope and seepage moderately limit the use of this soil for a sewage lagoon system. Onsite investigation is needed to locate the less sloping areas, which are desirable, and the sandy areas, which are undesirable. Some sandy areas can be bedded over with good clay material. Capability subclass IIe; Loamy Upland range site.

Pa—Pawnee clay loam, 1 to 3 percent slopes. This deep, gently sloping, well drained to moderately well drained soil is on convex ridgetops and side slopes in the uplands. Areas are irregularly shaped.

Typically, the surface layer is black clay loam about 10 inches thick. The subsoil is about 42 inches thick. The upper part is very dark gray, friable clay loam, and the lower part is dark brown and yellowish brown, very firm clay. The underlying material to a depth of about 60 inches is yellowish brown clay. In places large glacial boulders are throughout the profile. In some areas there are thin strata of more sandy or gravelly material. In a few areas a limestone layer is within a depth of 36 inches.

Included with this soil in mapping are small areas of Burchard, Shelby, Martin, and Wymore soils. These soils make up about 10 percent of the unit. The Wymore soils formed in loess. They are at a higher elevation than this Pawnee soil. The Burchard and Shelby soils are generally more sloping than this Pawnee soil and contain less clay in the subsoil. Also, they are on lower slopes. The Martin soils are less sandy than the Pawnee soil, and they are intermingled with it where the deposit of glacial till is thin and is underlain by shale or other rock.

Water and air move through this soil at a slow rate, and surface runoff is medium. Available water capacity is moderate. Reaction varies in the surface layer as a result of local farming and liming practices. The subsoil ranges

from slightly acid to moderately alkaline. Organic-matter content is moderate, and natural fertility is high. The surface layer is friable and can be easily tilled, but it tends to crust following hard rains. The very firm clay in the subsoil restricts roots. The shrink-swell potential is high.

Most areas are farmed, and some are in range or pasture. This soil has good potential for cultivated crops, range, pasture, and hay and poor potential for recreation uses. It has good to fair potential for openland and rangeland wildlife habitat and poor potential for most engineering uses.

This soil is suited to sorghum, soybeans, corn, and small grain and to grasses and legumes grown for hay or pasture. Corn is not so well suited as other crops. If the soil is cultivated, maintaining fertility and tilth and controlling erosion are management needs. The hazard of erosion is moderate. Minimum tillage and cover crops maintain fertility and tilth, help to control erosion, and increase the rate of water infiltration. Returning crop residue to the soil, applying barnyard manure, and applying a proper amount of commercial fertilizer and lime improve fertility and reduce crusting. Terraces, grassed waterways, and contour farming help to control runoff and erosion.

This soil is well suited to range and pasture. A good cover of desirable native or tame grasses is effective in controlling erosion if the pasture or range is well managed. It also maintains good production. Proper stocking rates, pasture or range rotation, a timely season of use, timely deferment of grazing, and weed and brush control keep the grass and the soil in good condition. Tame grasses respond to applications of a proper amount of commercial fertilizer.

This soil is well suited to windbreaks. Special care is needed if young trees are to grow well. Rainfall is likely to be limited and irregular, and irrigating the trees promotes growth. Cultivating young windbreaks reduces competition for soil moisture. Windbreaks should be protected from livestock, fire, and rodents.

The high shrink-swell potential and low strength severely limit building site development. The harmful effects of shrinking and swelling and low strength can be overcome by careful design and proper construction. Enlarging footings and foundations and adding extra reinforcement steel can prevent cracking. Installing a drain tile surrounded by sand or gravel reduces variation in moisture levels, shrinking and swelling, and uplift pressure. Replacement of the soil surrounding the foundation with soil material that shrinks and swells less than this soil also is beneficial. Shrinking and swelling can be reduced by insulating foundations and floors with an intervening layer of sand or gravel below the depth of seasonal expansion. In some cases the entire basement floor can be reinforced so that it acts as a foundation. Diverting surface runoff or filling low areas provides good drainage.

The slow absorption of effluent severely limits the use of this soil as a septic tank absorption field. Other methods of sewage disposal, such as a sewage lagoon or a community sanitary sewer, should be considered. Increasing the size of the absorption field and installing perimeter drains around the absorption field improve the functioning of septic tank systems.

Sewage lagoons are well suited if the slope is less than 2 percent, but limitations are moderate if it is more than 2 percent. Onsite investigation is needed to locate the less sloping areas. Small lagoons can be constructed in some of the more sloping areas if embankments are used. Capability subclass IIe; Loamy Upland range site.

Pb—Pawnee clay loam, 3 to 7 percent slopes. This deep, moderately sloping, well drained to moderately well drained soil is on convex upland ridges and side slopes. Areas are irregularly shaped.

Typically, the surface layer is black clay loam about 10 inches thick. The subsoil is about 42 inches thick. The upper part is very dark gray, friable clay loam; the lower part is dark brown and yellowish brown, very firm clay. The underlying material to a depth of about 60 inches is yellowish brown clay. A few spots are eroded. In some areas large glacial boulders are throughout the profile. In places thin strata of sand or gravel are in the soil. In a few areas a limestone layer is within a depth of 36 inches.

Included with this soil in mapping are small areas of Burchard, Martin, Shelby, and Wymore soils. These soils make up about 10 to 15 percent of the unit. The Wymore soils formed in loess. They are at a higher elevation than this Pawnee soil. The Martin soils are less sandy than this Pawnee soil and are intermingled with it where the deposit of glacial till is thin and is underlain by shale or other rock. The Burchard and Shelby soils are steeper than the Pawnee soil and are lower lying. Also, they have a less clayey subsoil.

Water and air move through this soil at a slow rate, and surface runoff is rapid. Available water capacity is moderate. Reaction varies in the surface layer as a result of local liming practices. The subsoil ranges from slightly acid to moderately alkaline. Organic-matter content is moderate, and natural fertility is high. The surface layer is friable and can be easily tilled, but it tends to crust or puddle during and following hard rains. Roots are restricted by the clay in the subsoil. The shrink-swell potential is high.

Most areas are farmed. A few are in tame grass and native range. This soil has good potential for cultivated crops, range, and tame pasture. It has fair potential for recreation uses and good to fair potential for openland and rangeland wildlife habitat. It has poor potential for most engineering uses.

This soil is suited to sorghum, soybeans, corn, and small grain and to grasses and legumes grown for hay or pasture. Corn is not so well suited as other crops. The main management needs are maintaining fertility and tilth and controlling erosion. The hazard of erosion is moderate to severe. Minimizing tillage, growing cover crops, applying barnyard manure, and returning crop residue to the soil maintain organic-matter content, fer-

tility, and tilth and protect the soil against erosion. Grassed waterways, terraces, and contour farming are needed in most cultivated areas to control runoff and erosion. Crops respond well to applications of a proper amount of commercial fertilizer and lime.

The use of this soil for range, pasture, or hay helps to control erosion. If the pasture or range is overgrazed, erosion can occur and weedy or brushy plants can invade. Proper stocking rates, proper use, and desirable plants maintain good production and protect the soil against erosion. Tame grasses respond well to applications of a proper amount of fertilizer.

This soil is suited to windbreaks. Special care is needed if young trees are to grow well. Applying additional water during dry periods promotes growth. Control of weeds and competing vegetation conserves moisture. Windbreaks should be protected from livestock, fire, and rodents.

The high shrink-swell potential and low strength severely limit building site development. The harmful effects of shrinking and swelling and low strength can be overcome by careful design and proper construction. Enlarging footings and foundations and adding extra reinforcement steel help to prevent cracking. Installing a drain tile surrounded by sand or gravel reduces the variation in moisture levels, shrinking and swelling, and uplift pressure. Replacement of the soil surrounding the foundation with soil material that shrinks and swells less also is beneficial. Shrink-swell expansion can be reduced by insulating foundations and floors with an intervening layer of sand or gravel below the depth of seasonal expansion. In some cases the entire basement floor can be reinforced so that it acts as a foundation. Diverting surface water or filling low areas provides good drainage. Buildings should be constructed in the less sloping areas. Consideration of the design and location of structures is needed in planning footings and foundations. Retaining walls or piers help to support footings and foundations. A plant cover is needed to control erosion around buildings.

The slow absorption of effluent severely limits the use of this soil as a septic tank absorption field. Other methods of sewage disposal, such as a sewage lagoon or a community sanitary sewer, should be considered. Increasing the size of the absorption field and installing perimeter drains around the absorption field improve the functioning of septic tank systems.

The slope is a moderate limitation if this soil is used for sewage lagoons. Onsite investigation is needed to locate the less sloping areas. Small lagoons can be constructed in some of the more sloping areas if embankments are used. Sewage waste can be diverted to somewhat distant areas that are better suited to lagoons or septic tank absorption fields. Capability subclass IIIe; Loamy Upland range site.

Pc—Pawnee clay loam, 3 to 7 percent slopes, eroded. This deep, moderately sloping, well drained soil is on narrow, convex upland ridges and side slopes. Areas are irregularly shaped.

Typically, the surface layer is very dark gray clay loam about 5 inches thick. The subsoil is dark brown and yellowish brown, very firm clay about 36 inches thick. The underlying material to a depth of about 60 inches is yellowish brown clay. In some places the surface layer is thicker, and in others the clay subsoil is exposed. In some areas large glacial boulders are throughout the profile. In other areas thin strata of more sandy or gravelly material are in the soil. In a few areas a limestone layer is within a depth of 36 inches.

Included with this soil in mapping are small areas of Burchard, Martin, Shelby, and Wymore soils and severely eroded spots. These included areas make up about 20 to 25 percent of the unit. The Burchard and Shelby soils have a less clayey subsoil than this Pawnee soil. They are more sloping and are lower on the landscape. The Wymore soils formed in loess. They are in the higher positions on ridgetops. The Martin soils formed in residuum derived from shale or clay beds. They are in the lower positions on the landscape. Numerous gullies or gully scars are in the severely eroded spots.

Water and air move through this soil at a slow rate, and surface runoff is rapid. Reaction varies in the surface layer, depending on past farming and liming practices. The subsoil ranges from slightly acid to moderately alkaline. The soil is difficult to cultivate. A crust can form after heavy rains. The clay subsoil restricts roots. The shrink-swell potential is high.

Most areas are farmed or are in tame grasses or reseeded native grasses. This soil has good potential for range, pasture, and hay and fair potential for cultivated crops. It has poor potential for most engineering uses, fair potential for recreation uses, and good to fair potential for openland and rangeland wildlife habitat.

This soil is suited to small grain, sorghum, and soybeans and to grasses and legumes grown for hay or pasture. Corn is not so well suited as other crops. This soil produces moderate crop yields if it is well managed. It is subject to further erosion. Crops respond well to applications of a proper amount of commercial fertilizer and lime. Returning crop residue to the soil, applying barnyard manure, and planting green manure crops improve tilth and protect the soil against erosion. Minimum tillage, terraces, contour farming, and grassed waterways are needed to reduce soil loss. Diversion terraces are needed in some areas.

A cover of tame and native grasses helps to control erosion. Soil loss can occur and undesirable plants can grow, however, if management is poor. Proper stocking rates, pasture or range rotation, a timely season of use, timely deferment of grazing, and weed and brush control keep the grass and the soil in good condition. Most areas are cultivated or have been cultivated. As a result, establishing a grass cover can be difficult because of low fertility and a very slow rate of water absorption. If tame grasses are grown, applications of fertilizer are needed to maintain a good cover.

This soil is suited to windbreaks. Special care is needed when the trees are planted and when they are young. Applications of additional water during dry periods promote growth. Control of competing vegetation and weeds conserves moisture. Windbreaks should be protected from livestock, fire, and rodents.

The high shrink-swell potential and low strength severely limit building site development. The harmful effects of shrinking and swelling and low strength can be overcome by careful design and proper construction. Enlarging footings and foundations and adding extra reinforcement steel can prevent cracking. Installing a drain tile surrounded by sand or gravel reduces the variation in moisture levels, shrinking and swelling, and uplift pressure. Replacement of the soil surrounding the foundation with soil material that shrinks and swells less than this soil also is beneficial. Shrink-swell expansion can be reduced by insulating foundations and floors with an intervening layer of sand or gravel below the depth of seasonal expansion. In some cases the entire basement floor can be reinforced so that it acts as a foundation. Diverting surface water or filling low areas provides good drainage. Buildings should be constructed in the less sloping areas. Consideration of the design and location of structures is needed in planning footings and foundations. Retaining walls or piers help to support footings and foundations. A plant cover is needed to control erosion around buildings.

The slow absorption of effluent severely limits the use of this soil as a septic tank absorption field. Other methods of sewage disposal, such as a sewage lagoon or a community sanitary sewer, should be considered. Increasing the size of the absorption field and installing perimeter drains around the absorption field improve the functioning of septic tank systems.

The slope is a moderate limitation if this soil is used for sewage lagoons. Onsite investigation is needed to locate the less sloping areas. Small lagoons can be constructed in some of the more sloping areas if embankments are used. Sewage can be diverted to somewhat distant areas that are better suited to lagoons or septic tank absorption fields. Capability subclass IIIe; Loamy Upland range site.

Pt—Pits, quarries. This map unit is in areas from which the soil and much of the underlying limestone or shale have been removed. The underlying material has been removed for road gravel or for agricultural lime. Pits generally are bare areas surrounded by vertical walls. Some areas are filled with water. Scattered trees, shrubs, and clumps of grass grow in places.

The use of this unit for farming is limited. The potential for wildlife habitat or recreation uses is good. Capability class VIII; not assigned to a range site.

Ra—Reading silt loam. This deep, nearly level, well drained soil is on terraces and high bottoms away from the stream channel. It is rarely flooded. Areas are irregularly shaped.

Typically, the surface layer is black silt loam about 8 inches thick. The subsurface layer is black silty clay loam about 9 inches thick. The subsoil extends to a depth of more than 60 inches. The upper part is very dark brown, friable silty clay loam; the next part is very dark grayish brown, firm silty clay loam; and the lower part is dark brown, firm and very firm silty clay loam. In places the subsoil is more clayey.

Included with this soil in mapping are small areas of Chase, Kennebec, Olmitz, Wabash, and Zook soils. These soils make up about 10 percent of the unit. The Chase and Olmitz soils are next to the upland and are rarely flooded. The Olmitz soils contain more sand than this Reading soil. The Wabash and Zook soils are in depressional areas on wide alluvial bottoms. The Chase, Wabash, and Zook soils are darker colored than this Reading soil and contain more clay in the subsoil. The Kennebec soils are next to the stream channels. They are less clayey than the Reading soil.

Air and water move through this soil at a moderately slow rate, and surface runoff is slow. Available water capacity is high. Reaction ranges from medium acid to neutral throughout. It varies in the upper part of the surface layer as a result of local farming practices. Organic-matter content is moderate, and natural fertility is high. The soil is easy to till. The shrink-swell potential is moderate.

Most areas are farmed. This soil has good potential for cultivated crops, range, hay, pasture, and trees. It has good potential for recreation uses and for openland and woodland wildlife habitat and fair potential for most engineering uses.

This soil is well suited to all of the cultivated crops commonly grown in the county, such as corn, sorghum, soybeans, small grain, and deep-rooted legumes. Erosion is not a problem, and flooding is rare. The principal management concerns are maintaining organic-matter content, fertility, and tilth. Minimizing tillage, returning crop residue to the soil, and applying fertilizer maintain fertility and tilth.

This soil can be used for range, pasture, or hay. Proper use, control of undesirable plants, proper stocking rates, and a timely season of use keep the soil and the grass in good condition and maintain or increase forage yields.

This soil is suited to woodland. Protection from grazing and fire and measures that thin the stands are needed.

The flooding severely limits building site development. The flood hazard can be reduced by using dikes and levees or raising the building by filling. The moderate shrink-swell potential is also a limitation. Special care and design can reduce the risk of damage caused by shrink-swell expansion. Enlarging footings and foundations, adding steel reinforcement, and insulating foundations and footings with a suitable intervening layer of sand and gravel reduce the risk of damage caused by shrinking and swelling. The moisture level and shrink-swell expansion can be controlled if drain tiles that are surrounded by gravel or sand are installed around footings.

The flooding and the slow absorption of effluent limit the use of this soil as a septic tank absorption field. Pro-

tection against flooding is needed. Increasing the size of the absorption field improves the functioning of septic tank systems.

This soil is suited to sewage lagoons if it is protected against flooding. Lagoons should be constructed in areas of nearly impervious soil material. In some areas the floor and sides of the lagoon pond should be bedded over with clay. Capability class I; Loamy Lowland range site.

Sa—Shelby clay loam, 4 to 8 percent slopes. This deep, moderately sloping, moderately well drained soil is on narrow ridges and side slopes along drainageways. Areas are long and irregularly shaped.

Typically, the surface layer is very dark brown clay loam about 15 inches thick. The subsoil is about 28 inches thick. The upper part is dark brown, friable clay loam; the lower part is brown, firm clay loam. Yellowish brown mottles are in the lower part. The underlying material is yellowish brown clay loam with accumulations of soft lime. In places the soil is redder, and in some areas sand or gravel pockets are below a depth of 30 inches. In places the underlying material is more clayey.

Included with this soil in mapping are small intermingled areas of Burchard, Kennebec, Olmitz, Pawnee, and Wymore soils. These soils make up about 12 percent of the unit. The Pawnee and Wymore soils are higher on the landscape than this Shelby soil and are less sloping. Also, they have a more clayey subsoil. The Burchard soils are calcareous at a depth of 15 to 30 inches. The Kennebec soils have a less clayey subsoil than this Shelby soil. They have gentle slopes and are along drainageways on uplands. The Olmitz soils have a thicker surface layer than the Shelby soil. They are on concave foot slopes.

Water and air move through this soil at a moderately slow rate, and surface runoff is rapid. Available water capacity is high. Reaction varies in the surface layer as a result of local liming practices. The subsoil is medium acid to neutral. Natural fertility is high, and organic-matter content is moderate. The surface layer tends to crust or puddle after a hard rain. The compact clay loam subsoil restricts roots. The shrink-swell potential is moderate.

Most areas are farmed. This soil has good potential for range, pasture, hay, and cultivated crops; for recreation uses; and for woodland wildlife habitat and rangeland wildlife habitat. It has poor potential for most engineering uses.

This soil is suited to corn, sorghum, soybeans, and small grain and to legumes or grasses grown for hay or pasture. It is subject to erosion. Management that controls erosion and maintains tilth and fertility is needed. Minimum tillage, cover crops, grassed waterways, terraces, and contour farming help to control runoff. Diversion terraces are needed to protect some areas against runoff from higher lying areas. Returning crop residue to the soil and applying barnyard manure improve tilth and organic-matter content and provide protection against erosion. Bromegrass is suitable in waterways. All cultivated crops and tame grasses respond to applications of a proper amount of fertilizer. In places lime is needed if legumes are grown.

Tame and native grasses are well suited to this soil. A grass cover helps to control erosion. If the pasture or range is overgrazed, the desirable plants are reduced, undesirable plants invade, and erosion damage occurs. Proper stocking rates and weed and brush control keep the grass and the soil in good condition, reduce the risk of erosion, and maintain or increase forage production. Good pond sites are available. Local sand or gravel pockets, however, should be removed or bedded over with clay. Otherwise, an alternative site should be selected.

This soil is well suited to windbreaks. Good care of young windbreaks is needed, and applications of additional water during dry periods promote growth. Control of competing vegetation and protection from livestock, fire, and rodents are needed.

The shrink-swell potential and the slope moderately limit building site development. Special care is needed in the design and construction of buildings. Enlarging footings and foundations and adding steel reinforcement reduce the risk of damage caused by shrinking and swelling. The moisture level can be controlled and shrink-swell expansion prevented if drain tiles that are surrounded by sand or gravel are installed around footings. Buildings should be constructed in the less sloping areas. Consideration of the design and location of structures is needed in planning footings and foundations. Retaining walls or piers help to support footings and foundations. A plant cover is needed to control erosion on building sites.

The moderately slow absorption of effluent severely limits the use of this soil as a septic tank absorption field. Other methods, such as a lagoon or sanitary sewer, should be considered. Enlargement of the absorption field improves the functioning of septic tank systems. Onsite investigation is needed to determine whether or not sand or gravel pockets are in the soil. These pockets can cause the effluent to be inadequately filtered and thus to contaminate the ground water supply.

The slope is a moderate limitation if this soil is used for sewage lagoons. Lagoons can be built in the less sloping areas or, if embankments are used, in the steeper areas. Sand or gravel pockets can cause seepage. They can be removed by excavation or sealed with impervious material. Capability subclass IIIe; Loamy Upland range site.

Sb—Shelby clay loam, 4 to 8 percent slopes, eroded. This deep, moderately sloping, moderately well drained soil is on narrow ridges and side slopes along drainageways. Areas are long and irregularly shaped.

Typically, the surface layer is very dark brown clay loam about 5 inches thick. The subsoil is about 25 inches thick. The upper part is dark brown, friable clay loam; the lower part is brown, firm clay loam. Yellowish brown mottles are in the lower part. The underlying material is yellowish brown clay loam with accumulations of soft lime. In places the soil is redder, and in some areas sand or gravel pockets are below a depth of 30 inches. In some small areas the surface layer is thicker. In places the underlying material is more clayey.

Included with this soil in mapping are small areas of Burchard, Kennebec, Olmitz, Pawnee, and Wymore soils and severely eroded spots. These included areas make up about 20 to 25 percent of the unit. The Pawnee and Wymore soils are higher on the landscape than this Shelby soil and are less sloping. Also, they have a more clayey subsoil. The Burchard soils are calcareous at a depth of 15 to 30 inches. The Kennebec soils have a less clayey subsoil than this Shelby soil and are less sloping. They are along drainageways on uplands. The Olmitz soils have a thicker surface layer than the Shelby soil. They are on concave foot slopes. Numerous gullies and gully scars are in the severely eroded spots.

Water and air move through this soil at a moderately slow rate, and surface runoff is rapid. Available water capacity is moderate to high. Reaction varies in the surface layer as a result of local liming and farming practices. The subsoil is medium acid to neutral. Natural fertility is medium, and organic-matter content is moderate. The surface layer tends to crust and puddle after hard rains. Roots are restricted by the compact clay loam subsoil. The shrink-swell potential is moderate.

Most areas are farmed. This soil has fair to good potential for cultivated crops. It has good potential for pasture, range, hay, recreation uses, and woodland wildlife habitat and rangeland wildlife habitat. It has poor potential for most engineering uses.

This soil is suited to corn, sorghum, soybeans, and small grain and to tame grasses and legumes grown for hay or pasture. It is subject to further erosion. Measures that control erosion and maintain fertility and tilth are needed. Minimum tillage, cover crops, grassed waterways, terraces, and contour farming are needed to control runoff. Returning crop residue to the soil and applying barnyard manure improve tilth, fertility, and organic-matter content and help to control erosion. Tame grasses can be used in grassed waterways. Tame grasses and cultivated crops respond well to applications of a proper amount of fertilizer. Lime is sometimes needed.

This soil is well suited to tame and native grasses, which can help to control erosion. Because it is eroded, reseeding grass is beneficial in some areas. Bromegrass and native grasses are suitable for reseeding. Proper stocking rates and weed and brush control are needed to keep the grass and the soil in good condition, to reduce the risk of erosion, and to improve forage production. Good pond sites are available, but in places sand or gravel pockets are in the soil. The pockets should be removed or bedded over with clay, or an alternative site should be selected.

This soil is well suited to windbreaks. Special care of young plantings is needed. Irrigation during dry periods promotes their growth. Weed control is needed. Windbreaks should be protected from livestock, fire, and rodents.

The moderate shrink-swell potential and the slope moderately limit building site development. Special care is needed in the design and construction of buildings. Enlarging footings and foundations and adding steel reinforcement reduce the risk of damage caused by shrinking and swelling. Moisture levels can be controlled and shrink-swell expansion prevented if drain tiles that are surrounded by sand and gravel are installed around footings. Buildings should be constructed in the less sloping areas. Consideration of the design and location of structures is needed in planning footings and foundations. Retaining walls or piers help to support footings and foundations. A plant cover is needed to control erosion on building sites.

The moderately slow absorption of effluent severely limits the use of this soil as a septic tank absorption field. Other methods, such as a lagoon or a sanitary sewer, should be considered. Enlargement of the absorption field improves the functioning of septic tank systems. Onsite investigation is needed to determine whether or not sand or gravel pockets are in the soil. These pockets can cause the effluent to be inadequately filtered and thus to contaminate the ground water supply.

The slope is a moderate limitation if this soil is used for sewage lagoons. Lagoons can be built in the less sloping areas or, if embankments are used, in the steeper areas. Sand or gravel pockets can cause seepage. They can be removed by excavation or sealed with impervious material. Capability subclass IIIe; Loamy Upland range site.

Va—Vinland silty clay loam, 6 to 14 percent slopes. This shallow, moderately sloping to moderately steep, somewhat excessively drained soil is along drainageways. Areas are irregularly shaped.

Typically, the surface layer is very dark grayish brown silty clay loam about 5 inches thick. The subsoil is very dark brown, firm silty clay loam about 6 inches thick. The underlying material is mixed grayish brown and dark brown silty clay loam over weathered silty and sandy shale, which is at a depth of 17 inches. In some places the depth to shale is more than 20 inches, and in others it is less than 10 inches. In some small areas the soil is more clayey throughout.

Included with this soil in mapping are small areas of Clime, Martin, Pawnee, and Sogn soils. These soils make up about 20 percent of the unit. The Clime, Martin, and Sogn soils occur as small bands, less than 200 feet wide, intermixed with areas of the Vinland soil on hillsides. The Clime soils are 20 to 40 inches deep over calcareous clayey shale and contain more clay throughout than the Vinland soil. The Martin soils are deeper and more clayey than the Vinland soil. The Sogn soils are less than 20 inches deep over limestone. The Pawnee soils are deep. They are higher on the landscape than the Vinland soil. In some areas shale or other rocks crop out.

Water and air move through this soil at a moderate rate, and runoff is rapid to excessive. Available water capacity is low. The shrink-swell potential is moderate. Fertility is medium in all areas but those where the soil is very shallow. Organic-matter content is low.

Most areas are used for range, pasture, or hay. This soil has poor potential for cropland. It has good potential for

pasture, range, and hayland and fair potential for woodland wildlife habitat and rangeland wildlife habitat. It has fair to poor potential for recreation uses and poor potential for most engineering uses.

This soil is generally not suited to crops. It is shallow, and it is erodible if the protective cover is removed. It is well suited to pasture and range. Proper stocking rates, rotation of grazing, and control of weeds and brush are needed to maintain a good grass cover that protects the soil against erosion. If tame grasses are grown, applications of an adequate amount of commercial fertilizer determined by soil tests are needed.

The shallowness and the slope moderately limit building site development. Onsite investigation to locate areas of the less sloping soils and some of the included areas of deeper soils is needed. Consideration of the design and location of structures can prevent the cracking of footings and foundations caused by slippage or expansion. Retaining walls and piers help to support footings and foundations. A plant cover is needed to control erosion on the building site.

The shallowness severely limits the use of this soil as a septic tank absorption field. Another method of waste disposal, such as a community sanitary sewer, should be considered. Elevating a dwelling or a disposal area can provide sufficient depth. Sewage can be diverted to areas more suitable for disposal. Limitations for sewage lagoons are severe because of the shallowness and the slope. Onsite investigation is needed to locate the included areas of deeper, less sloping soils. In some areas lagoons can be built if embankments are used. Capability subclass VIe; Loamy Upland range site.

Vb—Vinland-Rock outcrop complex, 20 to 40 percent slopes. This map unit consists of shallow, steep and very steep, somewhat excessively drained soils and Rock outcrop on side slopes. Areas are generally dissected by drainageways. They are generally long and irregularly shaped. They are about 35 percent Vinland soils and 30 percent Rock outcrop. The soils and Rock outcrop are so intricately mixed and are in areas so small that it is not practical to separate them in mapping.

Typically, the Vinland soil has a surface layer of very dark grayish brown silty clay loam about 5 inches thick. The subsoil is very dark brown, firm silty clay loam about 6 inches thick. The underlying material is mixed grayish brown and dark brown silty clay loam over weathered silty and sandy shale, which is at a depth of about 17 inches. In places the depth to shale is more than 20 inches, and in other small areas it is less than 10 inches.

The Rock outcrop part of the unit is in the steeper areas where shale or other rocks crop out or where the soil material is less than 4 inches thick. Vegetation is sparse.

Included with this unit in mapping are small areas of Sogn, Clime, and Martin soils. These soils make up 20 to 40 percent of the unit. The Sogn soils are shallow over limestone. They are above the Rock outcrop on the landscape. The Clime soils are moderately deep over calcareous, clayey shale, and the Martin soils are more than 40 inches deep. The Clime and Martin soils are between ledges of shale or other rock outcrop.

Permeability is moderate in Vinland soil and very slow in the areas of Rock outcrop. Available water capacity is low in the Vinland soil and very low in the areas of Rock outcrop. Surface runoff is excessive on the Vinland soil. Reaction is medium acid to mildly alkaline. Organic-matter content is low, and natural fertility is medium. The root zone extends to shale or bedrock, which is less than 20 inches from the surface in most places. The shrink-swell potential is moderate.

Most areas are in native grass and are used for pasture. Some support scrub brush and timber. The potential is good for range; poor for tame grass, hay, cultivated crops, and most engineering uses; and fair to poor for recreation uses. The Vinland soil has fair potential for woodland wildlife habitat and rangeland wildlife habitat.

This map unit is best suited to range. The major problems of range management are related to the hazard of erosion and the low available water capacity. The unit is so steep or rocky that the use of farm machinery is restricted in most areas. The soil is somewhat droughty because of the low available water capacity and the water losses by runoff. Management that maintains an adequate plant cover and ground mulch helps to prevent excessive soil losses. Overstocking and overgrazing the range reduce the protective plant cover and cause deterioration of the plant community. Under these conditions, the more desirable grasses are replaced by less productive grasses, weeds, and brush. Controlling weeds or brush and reseeding are very difficult. Proper stocking rates, uniform grazing distribution, timely deferment of grazing, and a planned grazing system are very important in keeping the range and the soil in good condition. Pond reservoir sites are limited.

This map unit is not suited to building site development or sanitary sewage disposal facilities because of the very steep slopes and the shallow and very shallow soils. Onsite investigation is needed to locate suitable sites. Benches between breaks, of deeper, less sloping soils, have some potential as a site for a building or a sewage disposal system. Other areas for building sites or sewage disposal systems should be considered. Capability subclass VIIe; Vinland soil in Loamy Upland range site, Rock outcrop not placed in a range site.

Vc—Vinland-Sogn complex, 5 to 20 percent slopes. This map unit consists of shallow, moderately sloping to steep, somewhat excessively drained soils on hillsides. Slopes are complex. Individual areas are long and narrow or irregularly shaped. They are about 45 percent Vinland soils and 40 percent Sogn soils. The two soils occur in such an intricate pattern that it is not practical to separate them in mapping.

Typically, the Vinland soil has a surface layer of very dark grayish brown silty clay loam about 5 inches thick. The subsoil is very dark brown, firm silty clay loam about 6 inches thick. The underlying material is mixed grayish

brown and dark brown silty clay loam over weathered silty and sandy shale, which is at a depth of about 17 inches. In some places the depth to shale is more than 20 inches, and in others it is less than 10 inches.

Typically, the Sogn soil has a surface layer of black silty clay loam about 12 inches thick. Limestone is at a depth of about 12 inches.

Included with this unit in mapping are areas of Clime, Martin, and Pawnee soils. These soils make up about 15 percent of the unit. The Martin and Pawnee soils are deep and the Clime soils moderately deep. The Pawnee soils generally are higher on the landscape than the Vinland and Sogn soils, and the Martin and Clime soils are intermingled with the Vinland and Sogn soils. Also included is shale or other rock outcrop.

Permeability is moderate in the Vinland and Sogn soils. Runoff is rapid to excessive. Available water capacity is low in the Vinland soil and very low in the Sogn soil. Reaction is slightly acid in the Vinland soil and mildly alkaline in the Sogn soil. Natural fertility is medium to high and organic-matter content is low in both soils. The shrink-swell potential is moderate.

Most areas are used as range, pasture, or hayland. These soils have fair potential for hay and tame pasture, good potential for native range, and poor potential for cultivated crops. The Vinland soil has fair potential for woodland wildlife habitat and rangeland wildlife habitat. The Sogn soil has poor potential for rangeland wildlife habitat. Both soils have fair to poor potential for recreation uses and poor potential for most engineering uses.

These soils are well suited to pasture and range. Some areas are difficult to manage as pasture or harvest for hay because of some steep slopes, which hinder the use of farm machinery. Mowing or reseeding is suitable in most areas.

Controlling erosion is the major concern in managing these soils. A permanent plant cover is an effective way to control erosion. Tame grasses and hay respond to applications of a proper amount of commercial fertilizer determined by soil tests. Proper stocking rates, rotation of range or pasture, deferment of grazing, and control of weeds and brush are needed to maintain a good grass cover and to maintain or increase forage production. Good pond sites are somewhat limited.

The shallowness and the slope moderately limit building site development on the Vinland soil. The shallowness to limestone is a severe limitation on the Sogn soil. The moderate shrink-swell potential of both soils also is a limitation. The harmful effects of these limitations can be overcome by careful design and construction. Onsite investigation is needed to locate the less sloping areas of Vinland soil. Consideration of the design and location of structures can prevent the cracking of footings and foundations caused by slippage or expansion. Retaining walls or piers help to support footings and foundations. Installing drain tiles surrounded by sand or gravel reduces the variations in moisture levels that cause shrinking and swelling, uplift pressure, and slippage. A plant cover is needed to control erosion on the building site.

The shallowness severely limits the use of these soils as septic tank absorption fields. The shallowness and the slope are severe limitations if the soils are used for sewage lagoons. Other methods of waste disposal, such as a community sanitary sewer, should be considered. Onsite investigation is needed to locate the included areas of less sloping, deeper soils. Elevating dwellings and disposal areas can provide sufficient depth. Sewage can be diverted to areas more suitable for disposal. Capability subclass VIe; Vinland in Loamy Upland range site, Sogn soil in Shallow Limy range site.

Wa—Wabash silty clay. This deep, nearly level or depressional, very poorly drained soil is in low backwater areas away from stream channels on large flood plains. It is subject to occasional flooding and ponding. Areas are irregularly shaped.

Typically, the surface layer is black silty clay about 24 inches thick. The subsoil extends to a depth of more than 60 inches. It is very dark gray and dark grayish brown, very firm silty clay. In places the surface layer is silty clay loam.

Included with this soil in mapping are small areas of Chase, Kennebec, Olmitz, and Reading soils. These soils make up about 10 percent of the unit. The Kennebec and Reading soils contain less clay than this Wabash soil. The Kennebec soils are next to stream channels, and the Reading soils are on high bottoms or terraces. The Chase and Olmitz soils are next to uplands on benches, high terraces, or foot slopes. The Olmitz soils contain more sand than the Wabash soil, and the Chase soils have a less clayey surface layer.

Air and water move through this soil at a very slow rate. Surface runoff is very slow, and ponding occurs in depressional areas. Reaction generally ranges from medium acid to neutral but is moderately alkaline below a depth of 40 inches. Available water capacity is high. Organic-matter content is moderate, and fertility is high. The soil is difficult to till. It is sticky and plastic when wet and very hard when dry. Deep, wide cracks form during dry periods. Roots are restricted. In some areas the water table is within a few inches of the surface during wet periods. The shrink-swell potential is high.

Most areas are farmed. This soil has good potential for cultivated crops, range, hay, pasture, and woodland. It has poor potential for recreation uses and most engineering uses. It has fair potential for wetland wildlife habitat.

This soil is suited to all of the cultivated crops commonly grown in the county if adequate drainage is provided. Surface drainage is usually needed, and in some years crops are drowned. Adequate drainage is essential for alfalfa production. The main concerns in managing this soil are draining excess water and maintaining fertility. Planting deep-rooted legumes, returning crop residue to the soil, applying a proper amount of fertilizer, and minimizing tillage maintain tilth and fertility. A bedding system removes excess water. In places diversion terraces are needed to control water that comes in from the adjacent higher slopes.

This soil can be used for range or pasture if adequate drainage is provided. Proper use, maintanance of desirable plants, good drainage, and avoidance of grazing during wet periods keep the grass and the soil in good condition.

If this soil is used as woodland, adequate drainage is needed. Controlling competing vegetation, staying off the soil when it is wet, avoiding burning or grazing, and selective cutting that thins the stands when needed increase production.

The flooding, the seasonal wetness, and the high shrink-swell potential severely limit building site development. Special care is needed in design and construction. A diversion terrace can divert water from the site. Dikes can provide protection against flooding. If drain tiles that are surrounded by sand or gravel are installed around footings, wetness can be prevented and the variation in moisture levels, the shrinking and swelling, and the uplift pressure can be reduced. In some areas filling is needed to provide surface drainage. Enlarging footings and foundations and adding extra reinforcement steel can prevent the cracking caused by shrink-swell expansion. Replacing the soil material surrounding the foundations and footings with material that shrinks and swells less than this soil also is beneficial. Shrinking and swelling can be reduced by insulating foundations and floors with an intervening layer of sand or gravel below the depth of seasonal expansion.

The slow absorption of effluent, the seasonal wetness, and the flooding severely limit the use of this soil as a septic tank absorption field. Other methods of disposal, such as a sewage lagoon or a sanitary sewer, should be considered. The flooding severely limits the use of the soil for sewage lagoons. Only the areas that are protected against flooding or the areas that are not flooded and are drained can be used for sewage lagoons. Capability subclass IIIw; Clay Lowland range site.

Wb—Wymore silty clay loam, 1 to 3 percent slopes. This deep, gently sloping, moderately well drained or well drained soil is on upland ridges and stream benches. Individual areas are irregularly shaped.

Typically, the surface layer is very dark gray silty clay loam about 6 inches thick. The subsoil is about 37 inches thick. The upper part is very dark brown, firm silty clay loam; the next part is very dark grayish brown and dark grayish brown, very firm silty clay; the lower part is dark grayish brown, firm silty clay loam. The underlying material to a depth of about 60 inches is brown, grayish brown, and pale brown silty clay loam. In places a buried soil is below a depth of 30 inches. In some areas the surface layer is thinner.

Included with this soil in mapping are small areas of Shelby, Martin, and Pawnee soils. These soils make up about 10 percent of the unit. They are on the lower ridgetops and side slopes. The Martin soils formed in residuum derived from shale or clay beds and are more clayey in the lower part than this Wymore soil. The Pawnee and Shelby soils formed in glacial till and contain more sand throughout than the Wymore soil.

Air and water move slowly through this soil. Surface runoff is medium. Available water capacity is high. Reaction varies in the surface layer as a result of local farming practices. The upper 30 inches ranges from medium acid to neutral and the lower 30 inches from neutral to moderately alkaline. Natural fertility is high, and organic-matter content is moderate. The surface layer can be easily worked, but it can crust or puddle during heavy rains. Roots are restricted by the clayey part of the subsoil. The shrink-swell potential is high.

Most areas are farmed. Some are in range or pasture. This soil has good potential for cropland, rangeland, and pastureland. It has fair potential for recreation uses and for openland and rangeland wildlife habitat. It has poor potential for most engineering uses.

This soil is suited to corn, sorghum, soybeans, and small grain and to grasses and legumes grown for hay and pasture. The hazard of erosion is moderate. The main management needs are maintaining organic-matter content, tilth, and fertility and controlling erosion. Minimizing tillage, returning crop residue to the soil, and applying barnyard or green manure and a proper amount of fertilizer maintain fertility and tilth, help to control erosion, increase the rate of water absorption, and reduce crusting. Contour farming, terraces, and grassed waterways are needed to control runoff on most fields.

Tame and native perennial grasses are well suited to this soil and are effective in controlling erosion. Proper use, rotation grazing, and applications of a proper amount of fertilizer in areas of tame grasses maintain a good cover of desirable plants and thus maintain good production and help to control erosion.

This soil is well suited to windbreaks. Special care is needed when the trees are planted and when they are young. Applying additional water during dry periods promotes growth. Control of undesirable plants reduces plant competition. Windbreaks should be protected from grazing, fire, and rodents.

The high shrink-swell potential and low strength severely limit building site development. The harmful effects of shrinking and swelling and low strength can be overcome by careful design and proper construction. Enlarging footings and foundations and adding extra reinforcement steel can prevent cracking. Installing a drain tile surrounded by sand or gravel reduces the variation in moisture levels, the shrinking and swelling, and the uplift pressure. Replacing the soil surrounding the foundation with soil material that shrinks and swells less than this soil also is beneficial. Shrink-swell expansion can be reduced by insulating foundations and floors with an intervening layer of sand or gravel. In some cases the entire basement floor can be reinforced so that it acts as a foundation. Diverting surface water or filling low areas provides good drainage. A plant cover is needed to control erosion around buildings.

The slow absorption of effluent severely limits the use of this soil as a septic tank absorption field. Other methods of sewage disposal, such as a sewage lagoon or a

community sanitary sewer should be considered. Increasing the size of the absorption field and installing perimeter drains around the absorption field improve the functioning of septic tank systems.

Sewage lagoons are well suited to the soils where the slope is less than 2 percent, but the soil has moderate limitations if the slope is more than 2 percent. Onsite investigation is needed to locate the less sloping areas. Small lagoons can be constructed in some of the more sloping areas if embankments are used. Sewage can be diverted to somewhat distant areas that are better suited to lagoons and septic tank absorption fields. Capability subclass IIe; Clay Upland range site.

Wc—Wymore silty clay loam, 2 to 5 percent slopes, eroded. This deep, gently sloping to moderately sloping, moderately well drained or well drained soil is on upland ridges and stream benches. Individual areas are irregularly shaped.

Typically, the surface layer is very dark gray or very dark brown silty clay loam about 5 inches thick. The subsoil is about 33 inches thick. The upper part is very dark grayish brown, very firm silty clay; the lower part is dark grayish brown, firm silty clay loam. The underlying material to a depth of about 60 inches is brown, grayish brown, and pale brown silty clay loam. In places a buried soil is below a depth of 30 inches. Gullies or gully scars are evident in most areas. In a few small areas the surface layer is thicker.

Included with this soil in mapping are small areas of Shelby, Martin, and Pawnee soils. These soils make up about 12 percent of the unit. They are on the lower ridgetops and side slopes. The Martin soils formed in residuum derived from shale or clay beds and are more clayey in the lower part than this Wymore soil. The Pawnee and Shelby soils formed in glacial till and contain more sand throughout than the Wymore soil.

Air and water move through this soil at a slow rate, and surface runoff is medium. Available water capacity is moderate to high. Reaction varies in the surface layer, depending on past farming practices and management. Organic-matter content is moderate, and natural fertility is high. The upper part of the subsoil is medium acid to neutral. Reaction is neutral to moderately alkaine below a depth of 30 inches. The soil is difficult to till because of the content of clay in the surface layer and subsoil. The surface layer can crust following heavy rains. The clayey part of the subsoil restricts roots. The shrink-swell potential is high.

Most areas are farmed. This soil has good potential for cultivated crops, pasture, and range. It has fair potential for recreation uses and for openland and rangeland wildlife habitat. It has poor potential for most engineering uses.

This soil is suited to corn, small grain, sorghum, soybeans, and legumes and grasses. It is eroded and is subject to further erosion, but it produces moderate yields of cultivated crops if it is well managed. Applications of commercial fertilizer increase yields. Returning crop residue to the soil and applying barnyard manure and green manure crops improve tilth and protect the soil against erosion. Minimum tillage, contour farming, terraces, and grassed waterways are needed to reduce soil loss. Diversion terraces are needed on some stream benches as protection against runoff from adjacent areas.

Tame and native grasses are effective in controlling erosion. Establishing a grass cover can be difficult because of low fertility and a slow rate of water absorption. As a result of improper use, additional soil is lost and undesirable plants increase. Proper use and good management are needed. If tame grasses are grown, applications of commercial fertilizer are needed to maintain a good grass cover.

This soil is suited to windbreaks. Establishing windbreaks can be difficult because of the thin surface layer and the clayey subsoil. Special care is needed when the trees are planted and as they become established. Additional water is sometimes needed during dry periods. Windbreaks should be protected from livestock, fire, and rodents.

The high shrink-swell potential and low strength severely limit building site development. The harmful effects of shrinking and swelling and low strength can be overcome by careful design and proper construction. Enlarging footings and foundations and adding extra reinforcement steel can prevent cracking. Installing a drain tile surrounded by sand or gravel reduces the variation in moisture levels, the shrinking and swelling, and the uplift pressure. Replacing the soil surrounding the foundation with soil material that shrinks and swells less than this soil also is beneficial. Shrink-swell expansion can be reduced by insulating foundations and floors with an intervening layer of sand or gravel below the depth of seasonal expansion. In some cases the entire basement floor can be reinforced so that it acts as a foundation. Retaining walls help to support footings and foundations. Diverting surface water or filling low areas provides good drainage. Buildings should be constructed in the less sloping areas. A plant cover is needed to control erosion around buildings.

This soil is severely limited as a septic tank absorption field because it absorbs effluent slowly. Other methods of sewage disposal, such as a sewage lagoon or a community sanitary sewer, should be considered. Increasing the size of the absorption field and installing perimeter drains around the absorption field improve the functioning of septic tank systems.

The slope is a moderate limitation if this soil is used for sewage lagoons. Onsite investigation is needed to locate the less sloping areas. Small lagoons can be constructed in some of the more sloping areas if embankments are used. Sewage can be diverted to somewhat distant areas that are better suited to lagoons and septic tank absorption fields. Capability subclass IIIe; Clay Upland range site.

Za—Zook silty clay loam. This deep, nearly level, poorly drained soil is in backwater areas away from stream channels on flood plains. It is subject to occasional flooding and ponding. Areas are irregularly shaped.

Typically, the surface layer is black silty clay loam about 18 inches thick. The subsurface layer is black silty clay about 20 inches thick. The subsoil extends to a depth of more than 60 inches. It is dark gray, extremely firm silty clay. In places the surface layer is thinner.

Included with this soil in mapping are small areas of Chase, Kennebec, Olmitz, and Reading soils. These soils make up about 10 percent of the unit. The Kennebec soils are next to stream channels. They are less clayey than this Zook soil. The Chase and Reading soils are in the higher positions on high bottoms or terraces. They have a thinner surface layer than this Zook soil. The Olmitz soils are on foot slopes next to uplands. They contain more sand than the Zook soil.

Air and water move through this soil at a slow rate. Surface runoff is slow to very slow, and ponding occurs in a few slight depressions. Reaction ranges from medium acid to neutral. Available water capacity is high. Natural fertility is high, and organic-matter content is moderate. The soil is fairly easy to till. Roots are restricted by the underlying clay. The water table is below a depth of 15 inches. The shrink-swell potential is high.

Most areas are farmed. This soil has good potential for cultivated crops, range, hay, pasture, and woodland. It has poor potential for most engineering and recreation uses and good potential for wetland wildlife habitat.

This soil is suited to all of the cultivated crops commonly grown in the county. In some areas crops are damaged unless surface drainage is adequate. The main practices needed are those that maintain organic-matter content and fertility. Minimizing tillage, returning crop residue to the soil, and including a deep-rooted legume in the crop rotation maintain or improve fertility, organic-matter content, and tilth. In places drainage ditches are needed to keep water from ponding in depressions. In some areas diversion terraces are needed to protect the soil against runoff from adjacent uplands. Crop production can be increased by applying a proper amount of fertilizer and lime.

This soil is suited to range or pasture. Proper stocking rates, control of undesirable plants, and avoidance of grazing when the soil is too wet keep the soil and the grass in good condition.

This soil can be used as woodland. Controlling or removing competing vegetation, not working the soil when it is wet, and protecting wooded areas from grazing are management needs. Thinning the tree stand by selective cutting is often needed. Prevention of fires is needed.

This soil is poorly suited to building site development because it is subject to flooding and has a high shrink-swell potential. It is seasonally wet. Special care is needed in design and construction. A diversion terrace can be used to divert water away from the building site. Dikes can be used to protect the site against flooding. If drain tiles that are surrounded by sand or gravel are installed around footings, wetness can be prevented and the variation in moisture levels, the shrinking and swelling, and the uplift pressure can be reduced. In some depressional areas, filling is needed to provide satisfactory surface drainage. Enlarging footings and foundations and adding extra reinforcement steel can prevent the cracking caused by shrink-swell expansion. Replacing the soil surrounding the foundations and footings with soil material that shrinks and swells less than this soil also is beneficial. Shrinking and swelling can be reduced by insulating foundations and floors with an intervening layer of sand or gravel below the depth of seasonal expansion.

The slow absorption of effluent, the seasonal wetness, and the flooding severely limit the use of this soil as a septic tank absorption field. A diversion terrace can divert water away from the site. Areas that are not flooded or are protected against flooding should be selected. Enlarging the absorption field improves the functioning of septic tank systems. Other methods of disposal, such as a lagoon or a sanitary sewer, should be considered.

The flooding severely limits the use of this soil for sewage lagoons. If water is diverted and the site is protected against flooding or is not flooded and is drained, sewage lagoons are suitable. Capability subclass IIw; Clay Lowland range site.

Use and management of the soils

The soil survey is a detailed inventory and evaluation of the most basic resource of the survey area—the soil. It is useful in adjusting land use, including urbanization, to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in uses of the land.

While a soil survey is in progress, soil scientists, conservationists, engineers, and others keep extensive notes about the nature of the soils and about unique aspects of behavior of the soils. These notes include data on erosion, drought damage to specific crops, yield estimates, flooding, the functioning of septic tank disposal systems, and other factors affecting the productivity, potential, and limitations of the soils under various uses and management. In this way, field experience and measured data on soil properties and performance are used as a basis for predicting soil behavior.

Information in this section is useful in planning use and management of soils for crops and pasture, rangeland, and woodland, as sites for buildings, highways and other transportation systems, sanitary facilities, and parks and other recreation facilities, and for wildlife habitat. From the data presented, the potential of each soil for specified land uses can be determined, soil limitations to these land uses can be identified, and costly failures in houses and other structures, caused by unfavorable soil properties, can be avoided. A site where soil properties are favorable can be selected, or practices that will overcome the soil limitations can be planned.

Planners and others using the soil survey can evaluate the impact of specific land uses on the overall productivi-

ty of the survey area or other broad planning area and on the environment. Productivity and the environment are closely related to the nature of the soil. Plans should maintain or create a land-use pattern in harmony with the natural soil.

Contractors can find information that is useful in locating sources of sand and gravel, roadfill, and topsoil. Other information indicates the presence of bedrock, wetness, or very firm soil horizons that cause difficulty in excavation.

Health officials, highway officials, engineers, and many other specialists also can find useful information in this soil survey. The safe disposal of wastes, for example, is closely related to properties of the soil. Pavements, sidewalks, campsites, playgrounds, lawns, and trees and shrubs are influenced by the nature of the soil.

Crops and pasture

The major management concerns in the use of the soils for crops and pasture are described in this section. In addition, the crops or pasture plants best suited to the soil, including some not commonly grown in the survey area, are discussed; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are presented for each soil.

This section provides information about the overall agricultural potential of the survey area and about the management practices that are needed. The information is useful to equipment dealers, land improvement contractors, fertilizer companies, processing companies, planners, conservationists, and others. For each kind of soil, information about management. is presented in the section "Soil maps for detailed planning." Planners of management systems for individual fields or farms should also consider the detailed information given in the description of each soil.

More than 364,000 acres in the survey area was used for crops and pasture in 1975. Of this total, 175,000 acres was cropland and 189,000 acres grassland.

The potential of the soils in Jackson County for increased production of food is good. About 50,000 acres of potentially good cropland is currently used as grassland and woodland. In addition to the reserve productive capacity represented by this acreage, food production could also be increased considerably by extending the latest crop production technology to all cropland in the county. This soil survey can greatly facilitate the application of such technology.

The acreage in crops and pasture is gradually decreasing as more and more land is used for urban development. In 1975, an estimated 15,000 acres was urban and built-up land. The acreage under urban development has been growing at the rate of about 50 acres per year. The use of this soil survey to help make land-use decisions that will influence the future role of farming in the county is described under the heading "General soil map for broad land-use planning."

Soil erosion is the major soil problem on most of the cropland and pasture in Jackson County. If the slope is more than 2 percent, erosion is a hazard. Burchard, Martin, Olmitz, Pawnee, Shelby, and Wymore soils, for example, have slopes of 2 percent or more.

Loss of the surface layer through erosion is damaging for two reasons. First, productivity is reduced as the surface layer is lost and part of the subsoil is incorporated into the plow layer. Loss of the surface layer is especially damaging on soils with a clayey subsoil, such as Burchard, Martin, Pawnee, Shelby, and Wymore soils, and on soils with a layer, in or below the subsoil, that limits the depth of the root zone. Such layers include the shale in Clime and Vinland soils and the bedrock in Sogn soils. Second, soil erosion on farmland results in sediment entering streams. Control of erosion minimizes the pollution of streams by sediment and improves the quality of water for municipal use, for recreation, and for fish and wildlife.

In the clayey or hardpan spots in many sloping fields, preparing a good seedbed and tilling are difficult because the original friable surface soil has been eroded away. Such spots are common in areas of the eroded Martin, Pawnee, and Wymore soils.

Erosion control provides protective surface cover, reduces runoff, and increases the rate of infiltration. A cropping system that keeps a plant cover on the soil for extended periods can hold soil erosion losses to an amount that will not reduce the productive capacity of the soils. On livestock farms, which require pasture and hay, including legume and grass forage crops in the cropping system reduces the risk of erosion on sloping soils and also provides nitrogen and improves tilth for the following crop.

Slopes are so short and irregular that terracing is not practical in some areas of the moderately steep Burchard and Shelby soils. On these soils minimum tillage and a cropping system that provides substantial plant cover is needed to control erosion. Minimizing tillage and leaving crop residue on the surface increase the infiltration rate and reduce the hazards of runoff and erosion. They can be adapted to most soils in the survey area, but are less successful on the eroded clayey soils, such as Martin, Pawnee, and Wymore soils. No tillage for corn, grain sorghum, and soybeans, which is common on an increasing acreage, is effective in reducing the risk of erosion on sloping soils. It can be adapted to most soils in the survey area, but it is less successful on the soils with a clayey surface layer.

Terraces and diversions reduce the length of slopes and the risks of runoff and erosion. They are most practical on deep, well drained and moderately well drained soils that have regular slopes. Most of the arable soils on uplands in Jackson County are suitable for terraces. The other soils are less suitable because of irregular slopes or because of bedrock or shale within a depth of 10 inches. Contour farming and terraces help to reduce runoff and soil loss.

Soil blowing is a hazard on many soils. It can damage the soils in a few hours if winds are strong and the soils are dry and bare of vegetation or surface mulch. Maintaining a plant cover or surface mulch or keeping the surface rough through proper tillage minimizes soil blowing.

Information about the design of erosion-control practices for each kind of soil is contained in the Technical Guide, available in local offices of the Soil Conservation Service.

Soil drainage is the major management need on about 6 percent of the acreage used for crops and pasture in the survey area. Some soils are naturally so wet that the production of the crops commonly grown in the area is difficult. These are the poorly drained and very poorly drained Wabash and Zook soils, which make up about 22,000 acres in the survey area. Unless artificially drained, these soils are so wet that crops are damaged during wet years. The design of the drainage system varies according to the kind of soil. Finding adequate outlets for drainage systems is difficult in some areas. Information about the design that is needed on each kind of soil is contained in the Technical Guide, available in local offices of the Soil Conservation Service.

Soil fertility is naturally low in most soils in the uplands. All soils but Burchard and Clime soils are naturally acid. The soils on flood plains, such as Chase, Kennebec, Reading, Wabash, and Zook soils, range from slightly acid to mildly alkaline and are naturally higher in content of plant nutrients than most upland soils.

On the many upland soils that are naturally acid, applications of ground limestone are needed to raise the pH level sufficiently for good growth of alfalfa and other crops that grow only on nearly neutral soils. The level of available phosphorous is naturally low in most of these soils. On all soils applications of lime and fertilizer should be based on the results of soil tests, on the need of the crop, and on the expected level of yields. The Cooperative Extension Service can help in determining the kinds and amounts of fertilizer and lime to apply.

Soil tilth is an important factor in the germination of seeds and in the infiltration of water into the soil. Soils with good tilth are granular and porous.

Most of the soils used for crops in the survey area have a silt loam, clay loam, or silty clay loam surface layer that is medium to low in content of organic matter. Generally, the structure of such soils is weak, and the surface crusts after intense rainfall. The crust is hard when it is dry, and it is nearly impervious to water. Once the crust forms, it reduces the infiltration rate and increases runoff. Regular applications of crop residue, manure, and other organic material and minimum tillage improve soil structure and reduce the likelihood of crust formation.

Fall plowing is generally not a good practice. About two-thirds of the cropland is sloping soils that are subject to damaging erosion if they are plowed in the fall.

The dark colored, very poorly drained Wabash soils are clayey, and poor tilth is a problem because the soils often stay wet until late in spring. If they are wet when plowed, they tend to be very cloddy when dry and good seedbeds are difficult to prepare. Plowing in the fall generally results in good tilth in the spring on Wabash soils.

Field crops suited to the soils and climate of the survey area include many that are not now commonly grown. Corn, grain sorghum, and soybeans are the main row crops. Sunflowers, navy beans, sweet corn, and similar crops can be grown if economic conditions are favorable.

Wheat is the most common close-growing crop in the county. Oats, barley, buckwheat, and flax could be grown, and grass seed from bromegrass, fescue, alfalfa, and clover could be produced.

The latest information about growing special crops can be obtained from local offices of the Cooperative Extension Service and the Soil Conservation Service.

Yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. Absence of an estimated yield indicates that the crop is not suited to or not commonly grown on the soil.

The estimated yields were based mainly on the experience and records of farmers, conservationists, and extension agents. Results of field trials and demonstrations and available yield data from nearby counties were also considered.

The yields were estimated assuming that the latest soil and crop management practices were used. Hay and pasture yields were estimated for the most productive varieties of grasses and legumes suited to the climate and the soil. A few farmers may be obtaining average yields higher than those shown in table 5.

The management needed to achieve the indicated yields of the various crops depends on the kind of soil and the crop. Such management provides drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate tillage practices, including time of tillage and seedbed preparation and tilling when soil moisture is favorable; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residues, barnyard manure, and green-manure crops; harvesting crops with the smallest possible loss; and timeliness of all fieldwork.

The estimated yields reflect the productive capacity of the soils for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not included because the acreage of these crops is small. The local of-

fices of the Soil Conservation Service and the Cooperative Extension Service can provide information about the management concerns and productivity of the soils for these crops.

Capability classes and subclasses

Capability classes and subclasses show, in a general way, the suitability of soils for most kinds of field crops. The soils are classed according to their limitations when they are used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops that require special management. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for forest trees, or for engineering purposes.

In the capability system, all kinds of soil are grouped at three levels: capability class, subclass, and unit (*9*). The capability class and subclass are defined in the following paragraphs. A survey area may not have soils of all classes.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants, or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants, or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and landforms have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w*, *s*, or *c* because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The capability subclass is identified in the description of each soil map unit in the section "Soil maps for detailed planning."

Rangeland

About 68,000 acres, or 16 percent of Jackson County, is rangeland. Most of the rangeland is in the western part of the county. Much of the farm income is derived from the sale of livestock, principally beef cattle. The total number of cattle in the county in 1974 was about 67,000, of hogs about 22,000, of sheep about 2,000, and of chickens about 38,000 (*5*).

The major source of livestock feed is native range and tame pasture, but the crops and their by-products are exensively used as supplemental feed. In winter the native forage is often supplemented with protein concentrate. Almost all of the rangeland in the county is intermingled with cultivated fields. The areas of rangeland are generally too rocky or too steep to be cultivated. Some areas have been set aside for native hay production.

The native vegetation in many parts of the survey area has been greatly depleted by continued excessive use. Much of the acreage that was once open grassland is now covered with brush, weeds, osageorange, and red cedar. In some areas the amount of forage produced is less than half of that originally produced. Productivity of rangeland can be increased through management that is effective for specific kinds of soil and range sites.

Where climate and topography are about the same, differences in the kind and amount of vegetation that rangeland can produce are related closely to the kind of soil. Effective management is based on the relationships among soils, vegetation, and water.

Table 6 shows, for each kind of soil, the name of the range site; the potential annual production of vegetation in favorable, normal, and unfavorable years; the characteristic vegetation; and the expected percentage of each species in the composition of the potential natural plant community. Soils not listed cannot support a natural plant community of predominately grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. The following are explanations of column headings in table 6.

A *range site* is a distinctive kind of rangeland that differs from other kinds of rangeland in its ability to produce a characteristic natural plant community. Soils that produce a similar kind, amount, and proportion of range plants are grouped into range sites (fig. 7). For those areas where the relationship between soils and vegetation has been established, range sites can be in-

terpreted directly from the soil map. Properties that determine the capacity of the soil to supply moisture and plant nutrients have the greatest influence on the productivity of range plants. Soil reaction, salt content, and a seasonal high water table are also important.

Potential production refers to the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It is expressed in pounds per acre of air-dry vegetation for favorable, normal, and unfavorable years. In a favorable year the amount and distribution of precipitation and the temperatures are such that growing conditions are substantially better than average; in a normal year these conditions are about average for the area; in an unfavorable year, growing conditions are well below average, generally because of low available soil moisture.

Dry weight refers to the total air-dry vegetation produced per acre each year by the potential natural plant community. Vegetation that is highly palatable to livestock and vegetation that is unpalatable are included. Some of the vegetation can also be grazed extensively by wildlife.

Common plant names of grasses, grasslike plants, forbs, and shrubs that make up most of the potential natural plant community on each soil are listed in table 6. Under *Composition*, the expected proportion of each species is presented as the percentage, in air-dry weight, of the total annual production of herbaceous and woody plants. The amount that can be used as forage depends on the kinds of grazing animals and on the grazing season. Generally all of the vegetation produced is not used.

Range management requires, in addition to knowledge of the kinds of soil and the potential natural plant community, an evaluation of the present condition of the range vegetation in relation to its potential. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential community, the better the range condition. The objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as the potential natural plant community for that site. Such management generally results in the maximum production of vegetation, conservation of water, and control of erosion. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

Woodland management and productivity

About 17,000 acres, or 4 percent of the land area in Jackson County, is woodland. About 95 percent of the woodland is used for grazing. Only a small part of the woodland is managed for timber production. Wooded areas also provide food and cover for wildlife, and some areas are used for recreation.

The woodland in the uplands is an oak-hickory association having an understory of grasses. This association is commonly referred to as a savannah type of plant association. Hickory, oak, elm, ash, osageorange, and other trees and sumac, buckbrush, and other small woody plants make up the woody vegetation. Most of the annual grass yield is of little bluestem and big bluestem. The rest is of indiangrass, sedges, switchgrass, Virginia wildrye, rosette panicums, and a variety of other species.

The woodland on bottom land is a lowland plains hardwood association. Ash, cottonwood, elm, willow, sycamore, bur oak, soft maple, black walnut, hackberry, hickory, boxelder, and other smaller woody plants make up the woodland vegetation. Elm, ash, and cottonwood make up the majority of the tree stand in the valley of the Delaware River. Elm, ash, black walnut, and hackberry make up the majority of the tree stand along the tributaries of the Delaware River and the Kansas River.

When they reach adequate size, most of the trees are cut for saw logs. A few are cut for fuel or for fenceposts. Hedgerows or fence rows of osageorange are throughout the county. Osageorange is used for fenceposts. Osageorange and eastern redcedar grow extensively on overgrazed pasture and range.

The bottom-land soils have a high potential for production of trees that grow to timber size, but most of these soils are used for crops. The upland soils have little potential for production of saw logs, but trees on the hilly uplands protect watersheds.

Table 7 contains information useful to woodland owners or forest managers planning use of soils for wood crops. Map unit symbols for soils suitable for wood crops are listed.

In table 7 the soils are also rated for a number of factors to be considered in management. *Slight*, *moderate*, and *severe* are used to indicate the degree of major soil limitations.

Ratings of the *erosion hazard* indicate the risk of loss of soil in well managed woodland. The risk is *slight* if the expected soil loss is small, *moderate* if some measures are needed to control erosion during logging and road construction, and *severe* if intensive management or special equipment and methods are needed to prevent excessive loss of soil.

Ratings of *equipment limitation* reflect the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. A rating of *slight* indicates that use of equipment is not limited to a particular kind of equipment or time of year; *moderate* indicates a short seasonal limitation or a need for some modification in management or equipment; *severe* indicates a seasonal limitation, a need for special equipment or management, or a hazard in the use of equipment.

Seedling mortality ratings indicate the degree that the soil affects expected mortality of planted tree seedlings. Plant competition is not considered in the ratings. Seedlings from good planting stock that are properly

planted during a period of sufficient rainfall are rated. A rating of *slight* indicates that the expected mortality of the planted seedlings is less than 25 percent; *moderate*, 25 to 50 percent; and *severe*, more than 50 percent.

Considered in the ratings of *windthrow hazard* are characteristics of the soil that affect the development of tree roots and the ability of the soil to hold trees firmly. A rating of *slight* indicates that trees in wooded areas are not expected to be blown down by commonly occurring winds; *moderate*, that some trees are blown down during periods of excessive soil wetness and strong winds; and *severe*, that many trees are blown down during periods of excessive soil wetness and moderate or strong winds.

Ratings of *plant competition* indicate the degree to which undesirable plants are expected to invade or grow if openings are made in the tree canopy. The invading plants compete with native plants or planted seedlings by impeding or preventing their growth. A rating of *slight* indicates little or no competition from other plants; *moderate* indicates that plant competition is expected to hinder the development of a fully stocked stand of desirable trees; *severe* means that plant competition is expected to prevent the establishment of a desirable stand unless the site is intensively prepared, weeded, or otherwise managed for the control of undesirable plants.

The *potential productivity* of merchantable or *important trees* on a soil is expressed as a *site index*. This index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands. Important trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

Trees to plant are those that are suitable for commercial wood production and that are suited to the soils.

Windbreaks and environmental plantings

Windbreaks are established to protect livestock, buildings, and yards from wind and snow. Windbreaks also help protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broad-leaved and coniferous species provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field, the interval depending on erodibility of the soil. They protect cropland and crops from wind, hold snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. A healthy planting stock of suitable species planted properly on a well prepared site and maintained in good condition can insure a high degree of plant survival.

Additional information about planning windbreaks and screens and the planting and care of trees can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from nurserymen.

Engineering

This section provides information about the use of soils for building sites, sanitary facilities, construction material, and water management. Among those who can benefit from this information are engineers, landowners, community planners, town and city managers, land developers, builders, contractors, and farmers and ranchers.

The ratings in the engineering tables are based on test data and estimated data in the "Soil properties" section. The ratings were determined jointly by soil scientists and engineers of the Soil Conservation Service using known relationships between the soil properties and the behavior of soils in various engineering uses.

Among the soil properties and site conditions identified by a soil survey and used in determining the ratings in this section were grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock that is within 5 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure or aggregation, in-place soil density, and geologic origin of the soil material. Where pertinent, data about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of absorbed cations were also considered.

On the basis of information assembled about soil properties, ranges of values can be estimated for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, shear strength, compressibility, slope stability, and other factors of expected soil behavior in engineering uses. As appropriate, these values can be applied to each major horizon of each soil or to the entire profile.

These factors of soil behavior affect construction and maintenance of roads, airport runways, pipelines, foundations for small buildings, ponds and small dams, irrigation projects, drainage systems, sewage and refuse disposal systems, and other engineering works. The ranges of values can be used to (1) select potential residential, commercial, industrial, and recreational uses; (2) make preliminary estimates pertinent to construction in a particular area; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for location of sanitary landfills, onsite sewage disposal systems, and other waste disposal facilities; (5) plan detailed onsite investigations of soils and geology; (6) find sources of gravel, sand, clay, and topsoil; (7) plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; (8) relate performance of structures already built to the properties of the kinds of soil on which they are built so that performance of similar struc-

tures on the same or a similar soil in other locations can be predicted; and (9) predict the trafficability of soils for cross-country movement of vehicles and construction equipment.

Data presented in this section are useful for land-use planning and for choosing alternative practices or general designs that will overcome unfavorable soil properties and minimize soil-related failures. Limitations to the use of these data, however, should be well understood. First, the data are generally not presented for soil material below a depth of 5 or 6 feet. Also, because of the scale of the detailed map in this soil survey, small areas of soils that differ from the dominant soil may be included in mapping. Thus, these data do not eliminate the need for onsite investigations, testing, and analysis by personnel having expertise in the specific use contemplated.

The information is presented mainly in tables. Table 8 shows, for each kind of soil, the degree and kind of limitations for building site development; and table 10, for sanitary facilities. Table 11 shows the kind of limitations for water management. Table 9 shows the suitability of each kind of soil as a source of construction materials.

The information in the tables, along with the soil map, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations and to construct interpretive maps for specific uses of land.

Some of the terms used in this soil survey have a special meaning in soil science. Many of these terms are defined in the Glossary.

Building site development

The degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets are indicated in table 8. A *slight* limitation indicates that soil properties generally are favorable for the specified use; any limitation is minor and easily overcome. A *moderate* limitation indicates that soil properties and site features are unfavorable for the specified use, but the limitations can be overcome or minimized by special planning and design. A *severe* limitation indicates that one or more soil properties or site features are so unfavorable or difficult to overcome that a major increase in construction effort, special design, or intensive maintenance is required. For some soils rated severe, such costly measures may not be feasible.

Shallow excavations are made for pipelines, sewerlines, communications and power transmission lines, basements, open ditches, and cemeteries. Such digging or trenching is influenced by soil wetness caused by a seasonal high water table; the texture and consistence of soils; the tendency of soils to cave in or slough; and the presence of very firm, dense soil layers, bedrock, or large stones. In addition, excavations are affected by slope of the soil and the probability of flooding. Ratings do not apply to soil horizons below a depth of 6 feet unless otherwise noted.

In the soil series descriptions, the consistence of each soil horizon is given, and the presence of very firm or extremely firm horizons, usually difficult to excavate, is indicated.

Dwellings and *small commercial buildings* referred to in table 8 are built on undisturbed soil and have foundation loads of a dwelling no more than three stories high. Separate ratings are made for small commercial buildings without basements and for dwellings with and without basements. For such structures, soils should be sufficiently stable that cracking or subsidence of the structure from settling or shear failure of the foundation does not occur. These ratings were determined from estimates of the shear strength, compressibility, and shrink-swell potential of the soil. Soil texture, plasticity and in-place density, potential frost action, soil wetness, and depth to a seasonal high water table were also considered. Soil wetness and depth to a seasonal high water table indicate potential difficulty in providing adequate drainage for basements, lawns, and gardens. Depth to bedrock, slope, and large stones in or on the soil are also important considerations in the choice of sites for these structures and were considered in determining the ratings. Susceptibility to flooding is a serious hazard.

Local roads and streets referred to in table 8 have an all-weather surface that can carry light to medium traffic all year. They consist of a subgrade of the underlying soil material; a base of gravel, crushed rock fragments, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. The roads are graded with soil material at hand, and most cuts and fills are less than 6 feet deep.

The load supporting capacity and the stability of the soil as well as the quantity and workability of fill material available are important in design and construction of roads and streets. The classifications of the soil and the soil texture, density, shrink-swell potential, and potential frost action are indicators of the traffic supporting capacity used in making the ratings. Soil wetness, flooding, slope, depth to hard rock or very compact layers, and content of large stones affect stability and ease of excavation.

Construction materials

The suitability of each soil as a source of roadfill, sand, gravel, and topsoil is indicated in table 9 by ratings of good, fair, or poor. The texture, thickness, and organic-matter content of each soil horizon are important factors in rating soils for use as construction materials. Each soil is evaluated to the depth observed, generally about 6 feet.

Roadfill is soil material used in embankments for roads. Soils are evaluated as a source of roadfill for low embankments, which generally are less than 6 feet high and less exacting in design than high embankments. The ratings reflect the ease of excavating and working the material and the expected performance of the material where it has been compacted and adequately drained. The

performance of soil after it is stabilized with lime or cement is not considered in the ratings, but information about some of the soil properties that influence such performance is given in the descriptions of the soil series.

The ratings apply to the soil material between the A horizon and a depth of 5 to 6 feet. It is assumed that soil horizons will be mixed during excavation and spreading. Many soils have horizons of contrasting suitability within their profile. The estimated engineering properties in table 14 provide specific information about the nature of each horizon. This information can help determine the suitability of each horizon for roadfill.

Soils rated *good* are coarse grained. They have low shrink-swell potential, low potential frost action, and few cobbles and stones. They are at least moderately well drained and have slopes of 15 percent or less. Soils rated *fair* have a plasticity index of less than 15 and have other limiting features, such as moderate shrink-swell potential, moderately steep slopes, wetness, or many stones. If the thickness of suitable material is less than 3 feet, the entire soil is rated *poor.*

Sand and *gravel* are used in great quantities in many kinds of construction. The ratings in table 9 provide guidance as to where to look for probable sources and are based on the probability that soils in a given area contain sizable quantities of sand or gravel. A soil rated *good* or *fair* has a layer of suitable material at least 3 feet thick, the top of which is within a depth of 6 feet. Coarse fragments of soft bedrock material, such as shale and siltstone, are not considered to be sand and gravel. Fine-grained soils are not suitable sources of sand and gravel.

The ratings do not take into account depth to the water table or other factors that affect excavation of the material. Descriptions of grain size, kinds of minerals, reaction, and stratification are given in the soil series descriptions and in table 14.

Topsoil is used in areas where vegetation is to be established and maintained. Suitability is affected mainly by the ease of working and spreading the soil material in preparing a seedbed and by the ability of the soil material to support plantlife. Also considered is the damage that can result at the area from which the topsoil is taken.

The ease of excavation is influenced by the thickness of suitable material, wetness, slope, and amount of stones. The ability of the soil to support plantlife is determined by texture, structure, and the amount of soluble salts or toxic substances. Organic matter in the A1 or Ap horizon greatly increases the absorption and retention of moisture and nutrients. Therefore, the soil material from these horizons should be carefully preserved for later use.

Soils rated *good* have at least 16 inches of friable loamy material at their surface. They are free of stones and cobbles, are low in content of gravel, and have gentle slopes. They are low in soluble salts that can limit or prevent plant growth. They are naturally fertile or respond well to fertilizer. They are not so wet that excavation is difficult during most of the year.

Soils rated *fair* are loose sandy soils or firm loamy or clayey soils in which the suitable material is only 8 to 16 inches thick or soils that have appreciable amounts of gravel, stones, or soluble salt.

Soils rated *poor* are very sandy soils and very firm clayey soils; soils with suitable layers less than 8 inches thick; soils having large amounts of gravel, stones, or soluble salt; steep soils; and poorly drained soils.

Although a rating of *good* is not based entirely on high content of organic matter, a surface horizon is generally preferred for topsoil because of its organic-matter content. This horizon is designated as A1 or Ap in the soil series descriptions. The absorption and retention of moisture and nutrients for plant growth are greatly increased by organic matter.

Sanitary facilities

Favorable soil properties and site features are needed for proper functioning of septic tank absorption fields, sewage lagoons, and sanitary landfills (*6*). The nature of the soil is important in selecting sites for these facilities and in identifying limiting soil properties and site features to be considered in design and installation. Also, those soil properties that affect ease of excavation or installation of these facilities will be of interest to contractors and local officials. Table 10 shows the degree and kind of limitations of each soil for such uses and for use of the soil as daily cover for landfills. It is important to observe local ordinances and regulations.

If the degree of soil limitation is expressed as *slight*, soils are generally favorable for the specified use and limitations are minor and easily overcome; if *moderate*, soil properties or site features are unfavorable for the specified use, but limitations can be overcome by special planning and design; and if *severe*, soil properties or site features are so unfavorable or difficult to overcome that major soil reclamation, special designs, or intensive maintenance is required. Soil suitability is rated by the terms *good*, *fair*, or *poor*, which, respectively, mean about the same as the terms *slight*, *moderate*, and *severe*.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into the natural soil. Only the soil horizons between depths of 18 and 72 inches are evaluated for this use. The soil properties and site features considered are those that affect the absorption of the effluent and those that affect the construction of the system.

Properties and features that affect absorption of the effluent are permeability, depth to seasonal high water table, depth to bedrock, and susceptibility to flooding. Stones, boulders, and shallowness to bedrock interfere with installation. Excessive slope can cause lateral seepage and surfacing of the effluent. Also, soil erosion and soil slippage are hazards if absorption fields are installed on sloping soils.

In some soils, loose sand and gravel or fractured bedrock is less than 4 feet below the tile lines. In these

soils the absorption field does not adequately filter the effluent, and ground water in the area may be contaminated.

On many of the soils that have moderate or severe limitations for use as septic tank absorption fields, a system to lower the seasonal water table can be installed or the size of the absorption field can be increased so that performance is satisfactory.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons have a nearly level floor and cut slopes or embankments of compacted soil material. Aerobic lagoons generally are designed to hold sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water. Soils that are very high in content of organic matter and those that have cobbles, stones, or boulders are not suitable. Unless the soil has very slow permeability, contamination of ground water is a hazard where the seasonal high water table is above the level of the lagoon floor. In soils where the water table is seasonally high, seepage of ground water into the lagoon can seriously reduce the lagoon's capacity for liquid waste. Slope, depth to bedrock, and susceptibility to flooding also affect the suitability of sites for sewage lagoons or the cost of construction. Shear strength and permeability of compacted soil material affect the performance of embankments.

Sanitary landfill is a method of disposing of solid waste by placing refuse in successive layers either in excavated trenches or on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil material. Landfill areas are subject to heavy vehicular traffic. Risk of polluting ground water and trafficability affect the suitability of a soil for this use. The best soils have a loamy or silty texture, have moderate to slow permeability, are deep to a seasonal water table, and are not subject to flooding. Clayey soils are likely to be sticky and difficult to spread. Sandy or gravelly soils generally have rapid permeability, which might allow noxious liquids to contaminate ground water. Soil wetness can be a limitation, because operating heavy equipment on a wet soil is difficult. Seepage into the refuse increases the risk of pollution of ground water.

Ease of excavation affects the suitability of a soil for the trench type of landfill. A suitable soil is deep to bedrock and free of large stones and boulders. If the seasonal water table is high, water will seep into trenches.

Unless otherwise stated, the limitations in table 10 apply only to the soil material within a depth of about 6 feet. If the trench is deeper, a limitation of slight or moderate may not be valid. Site investigation is needed before a site is selected.

Daily cover for landfill should be soil that is easy to excavate and spread over the compacted fill in wet and dry periods. Soils that are loamy or silty and free of stones or boulders are better than other soils. Clayey soils may be sticky and difficult to spread; sandy soils may be subject to soil blowing.

The soils selected for final cover of landfills should be suitable for growing plants. Of all the horizons, the A horizon in most soils has the best workability, more organic matter, and the best potential for growing plants. Thus, for either the area- or trench-type landfill, stockpiling material from the A horizon for use as the surface layer of the final cover is desirable.

Where it is necessary to bring in soil material for daily or final cover, thickness of suitable soil material available and depth to a seasonal high water table in soils surrounding the sites should be evaluated. Other factors to be evaluated are those that affect reclamation of the borrow areas. These factors include slope, erodibility, and potential for plant growth.

Water management

Many soil properties and site features that affect water management practices have been identified in this soil survey. In table 11 soil and site features that affect use are indicated for each kind of soil. This information is significant in planning, installing, and maintaining water-control structures.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have a low seepage potential, which is determined by permeability and the depth to fractured or permeable bedrock or other permeable material.

Embankments, dikes, and levees require soil material that is resistant to seepage, erosion, and piping and has favorable stability, shrink-swell potential, shear strength, and compaction characteristics. Large stones and organic matter in a soil downgrade the suitability of a soil for use in embankments, dikes, and levees.

Drainage of soil is affected by such soil properties as permeability; texture; depth to bedrock, hardpan, or other layers that affect the rate of water movement; depth to the water table; slope; stability of ditchbanks; susceptibility to flooding; salinity and alkalinity; and availability of outlets for drainage.

Irrigation is affected by such features as slope, susceptibility to flooding, hazards of water erosion and soil blowing, texture, presence of salts and alkali, depth of root zone, rate of water intake at the surface, permeability of the soil below the surface layer, available water capacity, need for drainage, and depth to the water table.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to intercept runoff. They allow water to soak into the soil or flow slowly to an outlet. Features that affect suitability of a soil for terraces are uniformity and steepness of slope; depth to bedrock, hardpan, or other unfavorable material; large stones; permeability; ease of establishing vegetation; and resistance to water erosion, soil blowing, soil slipping, and piping.

Grassed waterways are constructed to channel runoff to outlets at a nonerosive velocity. Features that affect the use of soils for waterways are slope, permeability, erodibility, wetness, and suitability for permanent vegetation.

Recreation

The soils of the survey area are rated in table 12 according to limitations that affect their suitability for recreation uses. The ratings are based on such restrictive soil features as flooding, wetness, slope, and texture of the surface layer. Not considered in these ratings, but important in evaluating a site, are location and accessibility of the area, size and shape of the area and its scenic quality, the ability of the soil to support vegetation, access to water, potential water impoundment sites available, and either access to public sewerlines or capacity of the soil to absorb septic tank effluent. Soils subject to flooding are limited, in varying degree, for recreation use by the duration and intensity of flooding and the season when flooding occurs. Onsite assessment of height, duration, intensity, and frequency of flooding is essential in planning recreation facilities.

The degree of the limitation of the soils is expressed as slight, moderate, or severe. *Slight* means that the soil properties are generally favorable and that the limitations are minor and easily overcome. *Moderate* means that the limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 12 can be supplemented by information in other parts of this survey. Especially helpful are interpretations for septic tank absorption fields, given in table 10, and interpretations for dwellings without basements and for local roads and streets, given in table 8.

Camp areas require such site preparation as shaping and leveling for tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils for this use have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing camping sites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for use as picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that will increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones or boulders, is firm after rains, and is not dusty when dry. If shaping is required to obtain a uniform grade, the depth of the soil over bedrock or hardpan should be enough to allow necessary grading.

Paths and trails for walking, horseback riding, bicycling, and other uses should require little or no cutting and filling. The best soils for this use are those that are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once during the annual period of use. They have moderate slopes and have few or no stones or boulders on the surface.

Wildlife habitat

ROBERT J. HIGGINS, biologist, Soil Conservation Service, helped prepare this section.

Soils directly affect the kind and amount of vegetation that is available to wildlife as food and cover, and they affect the construction of water impoundments. The kind and abundance of wildlife that populate an area depend largely on the amount and distribution of food, cover, and water. If any one of these elements is missing, is inadequate, or is inaccessible, wildlife either are scarce or do not inhabit the area.

If the soils have the potential, wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by helping the natural establishment of desirable plants.

In table 13, the soils in the survey area are rated according to their potential to support the main kinds of wildlife habitat in the area. This information can be used in planning for parks, wildlife refuges, nature study areas, and other developments for wildlife; selecting areas that are suitable for wildlife; selecting soils that are suitable for creating, improving, or maintaining specific elements of wildlife habitat; and determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* means that the element of wildlife habitat or the kind of habitat is easily created, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected if the soil is used for the designated purpose. A rating of *fair* means that the element of wildlife habitat or kind of habitat can be created, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* means that limitations are severe for the designated element or kind of wildlife habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* means that restrictions for the element of wildlife habitat or kind of wildlife are very severe, and that unsatisfactory results can be expected. Wildlife habitat is impractical or even impossible to create, improve, or maintain on soils having such a rating.

The elements of wildlife habitat are briefly described in the following paragraphs.

Grain and seed crops are seed-producing annuals used by wildlife. The major soil properties that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, sorghum, wheat, oats, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes that are planted for wildlife food and cover. Major soil properties that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, lovegrass, bluegrass, switchgrass, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds, that provide food and cover for wildlife. Major soil properties that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, indiangrass, goldenrod, switchgrass, and ragweed.

Hardwood trees and the associated woody understory provide cover for wildlife and produce nuts or other fruit, buds, catkins, twigs, bark, or foliage that wildlife eat. Major soil properties that affect growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness. Examples of native plants are oak, elm, hackberry, sycamore, hickory, black walnut, and box elder. Examples of fruit-producing shrubs that are commercially available and suitable for planting on soils rated *good* are Russian-olive, autumn-olive, and crabapple.

Coniferous plants are cone-bearing trees, shrubs, or ground cover plants that furnish habitat or supply food in the form of browse, seeds, or fruitlike cones. Soil properties that have a major effect on the growth of coniferous plants are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, spruce, cedar, and juniper.

Shrubs are bushy woody plants that produce fruit, seeds, buds, twigs, bark, or foliage used by wildlife or that provide cover and shade for some species of wildlife. Major soil properties that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and moisture. Examples of shrubs are sumac, buckbrush, blackberry, plum, gooseberry, and dogwood.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites, exclusive of submerged or floating aquatics. They produce food or cover for wildlife that use wetland as habitat. Major soil properties affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, barnyardgrass, buttonbush, indigobush, saltgrass, cordgrass, rushes, sedges, and cattail.

Shallow water areas are bodies of water that have an average depth of less than 5 feet and that are useful to wildlife. They can be naturally wet areas, or they can be created by dams or levees or by water-control structures in marshes or streams. Major soil properties affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. The availability of a dependable water supply is important if water areas are to be developed. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The kinds of wildlife habitat are briefly described in the following paragraphs.

Openland habitat consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The kinds of wildlife attracted to these areas include bobwhite quail, morning dove, meadowlark, field sparrow, and cottontail rabbit.

Woodland habitat consists of areas of hardwoods or conifers, or a mixture of both, and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include cardinals, thrushes, woodpeckers, squirrels, raccoon, deer, and opossum.

Wetland habitat consists of open, marshy or swampy, shallow water areas where water-tolerant plants grow. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, and beaver.

Rangeland habitat consists of areas of wild herbaceous plants and shrubs. Wildlife attracted to rangeland include white-tailed deer, mule deer, prairie dogs, jackrabbits, meadowlark, and lark bunting.

Soil properties

Extensive data about soil properties are summarized on the following pages. The two main sources of these data are the many thousands of soil borings made during the course of the survey and the laboratory analyses of selected soil samples from typical profiles.

In making soil borings during field mapping, soil scientists identify several important soil properties. They note the seasonal soil moisture condition or the presence of free water and its depth. For each horizon in the profile, they note the thickness and color of the soil material; the texture, or amount of clay, silt, sand, and gravel or other coarse fragments; the structure, or the natural pattern of cracks and pores in the undisturbed soil; and the consistence of the soil material in place under the existing soil moisture conditions. They record the depth of plant roots, determine the pH value or reaction of the soil, and identify any free carbonates.

Samples of soil material are analyzed in the laboratory to verify the field estimates of soil properties and to determine all major properties of key soils, especially properties that cannot be estimated accurately by field observation. Laboratory analyses are not conducted for all soil series in the survey area, but laboratory data for many soil series not tested are available from nearby survey areas.

The available field and laboratory data are summarized in tables. The tables give the estimated range of engineering properties, the engineering classifications, and the physical and chemical properties of each major horizon of each soil in the survey area. They also present data about pertinent soil and water features and engineering test data.

Engineering properties

Table 14 gives estimates of engineering properties and classifications for the major horizons of each soil in the survey area.

Most soils have, within the upper 5 or 6 feet, horizons of contrasting properties. Table 14 gives information for each of these contrasting horizons in a typical profile. *Depth* to the upper and lower boundaries of each horizon is indicated. More information about the range in depth and about other properties in each horizon is given for each soil series in the section "Soil series and morphology."

Texture is described in table 14 in the standard terms used by the U.S. Department of Agriculture (*8*). These terms are defined according to percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains gravel or other particles coarser than sand, an appropriate modifier is added, for example, "gravelly loam." Other texture terms are defined in the Glossary.

The two systems commonly used in classifying soils for engineering use are the Unified Soil Classification System (Unified) (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO) (*1*).

The *Unified* system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter, plasticity index, liquid limit, and organic-matter content. Soils are grouped into 15 classes—eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes have a dual classification symbol, for example, CL-ML.

The *AASHTO* system classifies soils according to those properties that affect their use in highway construction and maintenance. In this system a mineral soil is classified in one of seven basic groups ranging from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines. At the other extreme, in group A-7, are fine-grained soils. Highly organic soils are classified in group A-8 on the basis of visual inspection.

When laboratory data are available, the A-1, A-2, and A-7 groups are further classified as follows: A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, and A-7-6. As an additional refinement, the desirability of soils as subgrade material can be indicated by a group index number. These numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The AASHTO classification for soils tested in the survey area, with group index numbers in parentheses, is given in table 17. The estimated classification, without group index numbers, is given in table 14. Also in table 14 the percentage, by weight, of rock fragments more than 3 inches in diameter is estimated for each major horizon. These estimates are determined mainly by observing volume percentage in the field and then converting that, by formula, to weight percentage.

Percentage of the soil material less than 3 inches in diameter that passes each of four sieves (U.S. standard) is estimated for each major horizon. The estimates are based on tests of soils that were sampled in the survey area and in nearby areas and on field estimates from many borings made during the survey.

Liquid limit and *plasticity index* indicate the effect of water on the strength and consistence of soil. These indexes are used in both the Unified and AASHTO soil classification systems. They are also used as indicators in making general predictions of soil behavior. Range in liquid limit and plasticity index are estimated on the basis of test data from the survey area or from nearby areas and on observations of the many soil borings made during the survey.

In some surveys, the estimates are rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterburg limits extend a marginal amount across classification boundaries (1 or 2 percent), the classification in the marginal zone is omitted.

Physical and chemical properties

Table 15 shows estimated values for several soil characteristics and features that affect behavior of soils in engineering uses. These estimates are given for each major horizon, at the depths indicated, in the typical pedon of each soil. The estimates are based on field observations and on test data for these and similar soils.

Permeability is estimated on the basis of known relationships among the soil characteristics observed in the field—particularly soil structure, porosity, and gradation or texture—that influence the downward movement of water in the soil. The estimates are for vertical water

movement when the soil is saturated. Not considered in the estimates is lateral seepage or such transient soil features as plowpans and surface crusts. Permeability of the soil is an important factor to be considered in planning and designing drainage systems, in evaluating the potential of soils for septic tank systems and other waste disposal systems, and in many other aspects of land use and management.

Available water capacity is rated on the basis of soil characteristics that influence the ability of the soil to hold water and make it available to plants. Important characteristics are content of organic matter, soil texture, and soil structure. Shallow-rooted plants are not likely to use the available water from the deeper soil horizons. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design of irrigation systems.

Soil reaction is expressed as a range in pH values. The range in pH value of each major horizon is based on many field checks. For many soils, the values have been verified by laboratory analyses. Soil reaction is important in selecting the crops, ornamental plants, or other plants to be grown; in evaluating soil amendments for fertility and stabilization; and in evaluating the corrosivity of soils.

Shrink-swell potential depends mainly on the amount and kind of clay in the soil. Laboratory measurements of the swelling of undisturbed clods were made for many soils. For others the swelling was estimated on the basis of the kind and amount of clay in the soil and on measurements of similar soils. The size of the load and the magnitude of the change in soil moisture content also influence the swelling of soils. Shrinking and swelling of some soils can cause damage to building foundations, basement walls, roads, and other structures unless special designs are used. A high shrink-swell potential indicates that special design and added expense may be required if the planned use of the soil will not tolerate large volume changes.

Risk of corrosion pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to soil moisture, particle-size distribution, total acidity, and electrical conductivity of the soil material. The rate of corrosion of concrete is based mainly on the sulfate content, texture, and acidity of the soil. Protective measures for steel or more resistant concrete help to avoid or minimize damage resulting from the corrosion. Uncoated steel intersecting soil boundaries or soil horizons is more susceptible to corrosion than an installation that is entirely within one kind of soil or within one soil horizon.

Erosion factors are used to predict the erodibility of a soil and its tolerance to erosion in relation to specific kinds of land use and treatment. The soil erodibility factor (K) is a measure of the susceptibility of the soil to erosion by water. Soils having the highest K values are the most erodible. K values range from 0.10 to 0.64. To estimate annual soil loss per acre, the K value of a soil is modified by factors representing plant cover, grade and length of slope, management practices, and climate. The soil-loss tolerance factor (T) is the maximum rate of soil erosion, whether from rainfall or soil blowing, that can occur without reducing crop production or environmental quality. The rate is expressed in tons of soil loss per acre per year.

Wind erodibility groups are made up of soils that have similar properties that affect their resistance to soil blowing if cultivated. The groups are used to predict the susceptibility of soil to blowing and the amount of soil lost as a result of blowing. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are extremely erodible, so vegetation is difficult to establish. They are generally not suitable for crops.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible, but crops can be grown if intensive measures to control soil blowing are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible, but crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible, but crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible, but crops can be grown if measures to control soil blowing are used.

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible, but crops can be grown if measures to control soil blowing are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible, and crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible, and crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to soil blowing.

Soil and water features

Table 16 contains information helpful in planning land uses and engineering projects that are likely to be affected by soil and water features.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are placed in one of four groups on the basis of the intake of

water after the soils have been wetted and have received precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist chiefly of deep, well drained to excessively drained sands or gravels. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils that have a layer that impedes the downward movement of water or soils that have moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clay soils that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding is the temporary covering of soil with water from overflowing streams, with runoff from adjacent slopes, and by tides. Water standing for short periods after rains or after snow melts is not considered flooding, nor is water in swamps and marshes. Flooding is rated in general terms that describe the frequency and duration of flooding and the time of year when flooding is most likely. The ratings are based on evidence in the soil profile of the effects of flooding, namely thin strata of gravel, sand, silt, or, in places, clay deposited by floodwater; irregular decrease in organic-matter content with increasing depth; and absence of distinctive soil horizons that form in soils of the area that are not subject to flooding. The ratings are also based on local information about floodwater levels in the area and the extent of flooding and on information that relates the position of each soil on the landscape to historic floods.

The generalized description of flood hazards is of value in land-use planning and provides a valid basis for land-use restrictions. The soil data are less specific, however, than those provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table is the highest level of a saturated zone more than 6 inches thick for a continuous period of more than 2 weeks during most years. The depth to a seasonal high water table applies to undrained soils. Estimates are based mainly on the relationship between grayish colors or mottles in the soil and the depth to free water observed in many borings made during the course of the soil survey. Indicated in table 16 are the depth to the seasonal high water table; the kind of water table, that is, perched, artesian, or apparent; and the months of the year that the water table commonly is high. Only saturated zones above a depth of 5 or 6 feet are indicated.

Information about the seasonal high water table helps in assessing the need for specially designed foundations, the need for specific kinds of drainage systems, and the need for footing drains to insure dry basements. Such information is also needed to decide whether or not construction of basements is feasible and to determine how septic tank absorption fields and other underground installations will function. Also, a seasonal high water table affects ease of excavation.

Depth to bedrock is shown for all soils that are underlain by bedrock at a depth of 5 to 6 feet or less. For many soils, the limited depth to bedrock is a part of the definition of the soil series. The depths shown are based on measurements made in many soil borings and on other observations during the mapping of the soils. The kind of bedrock and its hardness as related to ease of excavation is also shown. Rippable bedrock can be excavated with a single-tooth ripping attachment on a 200-horsepower tractor, but hard bedrock generally requires blasting.

Potential frost action refers to the likelihood of damage to pavements and other structures by frost heaving and low soil strength after thawing. Frost action results from the movement of soil moisture into the freezing temperature zone in the soil, which causes ice lenses to form. Soil texture, temperature, moisture content, porosity, permeability, and content of organic matter are the most important soil properties that affect frost action. It is assumed that the soil is not covered by insulating vegetation or snow and is not artificially drained. Silty and clayey soils that have a high water table in winter are most susceptible to frost action. Well drained very gravelly or sandy soils are the least susceptible.

Engineering test data

Table 17 contains engineering test data for soils in some of the major soil series in Jackson County. These tests were made to help evaluate the soils for engineering purposes. The engineering classifications given are based on data obtained by mechanical analyses and by tests to determine liquid limits and plastic limits. The mechanical analyses were made by combined sieve and hydrometer methods.

Compaction, or moisture-density, data are important in earthwork. If a soil material is compacted at successively higher moisture content, assuming that the compactive effort remains constant, the density of the compacted material increases until the *optimum moisture content* is reached. After that, density decreases with increase in moisture content. The highest dry density obtained in the compactive test is termed *maximum dry density*. As a rule, maximum strength of earthwork is obtained if the soil is compacted to the maximum dry density.

Tests to determine liquid limit and plastic limit measure the effect of water on the consistence of soil material, as has been explained for table 14.

Soil series and morphology

In this section, each soil series recognized in the survey area is described in detail. The descriptions are arranged in alphabetic order by series name.

Characteristics of the soil and the material in which it formed are discussed for each series. The soil is then compared to similar soils and to nearby soils of other series. Then a pedon, a small three-dimensional area of soil that is typical of the soil series in the survey area, is described. The detailed descriptions of each soil horizon follow standards in the Soil Survey Manual (*8*). Unless otherwise noted, colors described are for moist soil.

Following the pedon description is the range of important characteristics of the soil series in this survey area. Phases, or map units, of each soil series are described in the section "Soil maps for detailed planning."

Burchard series

The Burchard series consists of deep, well drained soils on uplands. These soils formed in glacial till that is 5 to 12 feet thick. Permeability is moderately slow. Slopes range from 7 to 17 percent.

Burchard soils are similar to Olmitz and Shelby soils and are commonly adjacent to those soils and to Pawnee and Wymore soils on the landscape. Shelby soils lack soft lime within a depth of 30 inches. Pawnee and Wymore soils contain more clay in the argillic horizon than Burchard soils and are less sloping. Olmitz soils have a thicker surface layer than Burchard soils and contain more sand. They are on concave foot slopes below the Burchard soils.

Typical pedon of Burchard clay loam (fig. 8), in an area of Burchard-Shelby clay loams, 7 to 12 percent slopes, 620 feet east and 30 feet south of the northwest corner of sec. 13, T. 6 S., R. 14 E.

A1—0 to 8 inches; very dark brown (10YR 2/2) clay loam, very dark grayish brown (10YR 3/2) dry; moderate fine granular structure; soft, friable; neutral; gradual smooth boundary.

A3—8 to 14 inches; very dark grayish brown (10YR 3/2) clay loam, dark grayish brown (10YR 4/2) dry; moderate very fine subangular blocky structure; soft, friable; medium acid; gradual smooth boundary.

B2t—14 to 26 inches; dark yellowish brown (10YR 3/4) clay loam, dark yellowish brown (10YR 4/4) dry; strong fine to very fine subangular blocky structure; slightly hard, firm; thin discontinuous clay films; medium acid; clear smooth boundary.

B3—26 to 31 inches; dark yellowish brown (10YR 4/4) clay loam, yellowish brown (10YR 5/6) dry; moderate to strong fine subangular blocky structure; hard, firm; few pockets and streaks of soft lime; slight effervescence; moderately alkaline; diffuse smooth boundary.

C—31 to 60 inches; brown (10YR 5/3) heavy clay loam, pale brown (10YR 6/3) dry; few streaks of dark yellowish brown soil material containing less clay and few streaks of black soil material; massive; very hard, very firm; numerous streaks and pockets of soft lime; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 24 to 50 inches. The thickness of the mollic epipedon ranges from 7 to 20 inches. The depth to lime ranges from 15 to 30 inches. The upper part of the soil ranges from neutral to medium acid, and the lower part is moderately alkaline.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is clay loam or loam. The B horizon has hue of 10YR, value of 3 to 6, and chroma 3 or more. It is clay loam averaging between 30 and 35 percent clay. In some pedons it is more clayey. The C horizon is brown, grayish brown, or light brownish gray clay loam.

Chase series

The Chase series consists of deep, somewhat poorly drained to moderately well drained, slowly permeable soils on terraces or benches next to the uplands. These soils formed in thick clayey alluvium. Slopes are 0 to 2 percent.

Chase soils are similar to Olmitz, Reading, and Zook soils and are commonly adjacent to those soils and to Kennebec and Wabash soils on the landscape. The very poorly drained Wabash soils and the poorly drained Zook soils are on bottom land. They lack argillic horizons. Wabash soils are more clayey and Kennebec and Reading soils less clayey than Chase soils. Kennebec soils are on flood plains next to stream channels, and Reading soils are on high bottoms and terraces. Olmitz soils contain more sand than Chase soils. They are on foot slopes.

Typical pedon of Chase silty clay loam 1,200 feet west and 2,550 feet north of southeast corner of sec. 1, T. 7 S., R. 16 E.

A1—0 to 10 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak fine granular and weak fine subangular blocky structure: slightly hard, friable; neutral; gradual smooth boundary.

B1—10 to 21 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate fine granular structure; slightly hard, friable; slightly acid; diffuse smooth boundary.

B21t—21 to 34 inches; very dark gray (10YR 3/1) light silty clay, dark gray (10YR 4/1) dry; moderate fine subangular blocky structure; hard, firm; slightly acid; gradual smooth boundary.

B22t—34 to 45 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; few fine dark yellowish brown mottles; moderate medium subangular blocky structure; hard, firm; neutral; gradual smooth boundary.

C—45 to 60 inches; dark gray (10YR 4/1) silty clay, gray (10YR 5/1) dry; common fine dark yellowish brown mottles; nearly massive; hard, firm; few black concretions; mildly alkaline.

The thickness of the solum ranges from 36 to more than 60 inches. The mollic epipedon is more than 36 inches thick. Reaction ranges from medium acid to neutral in the A and B horizons and from slightly acid to mildly alkaline in the C horizon.

The A horizon is silt loam or silty clay loam. It has hue of 10YR, value of 2 or 3, chroma of 1 or 2. In some pedons a grayish layer is in the lower part of the A horizon. The B horizon has hue of 10YR, value of 2 to 4, and chroma of 1 or 2. The B horizon is silty clay, clay, or heavy silty clay loam. Mottles are evident below a depth of 30 inches in some pedons. The C horizon has the same range in color as B horizon and also has yellowish brown mottles. Small carbonate deposits are in the C horizon in some pedons.

Clime series

The Clime series consists of moderately deep, moderately well drained, slowly permeable soils on

uplands. These soils formed in residuum derived from calcareous clayey shale. Slopes range from 5 to 20 percent.

Clime soils are similar to Martin, Pawnee, Sogn, and Vinland soils and are adjacent to Martin, Pawnee, and Sogn soils on the landscape. Martin and Pawnee soils are more than 40 inches deep. Sogn and Vinland soils are less than 20 inches deep.

Typical pedon of Clime silty clay, in an area of Clime-Sogn complex, 5 to 20 percent slopes, 1,040 feet east and 150 feet south of the northwest corner of sec. 2, T. 9 S., R. 13 E.

A1—0 to 9 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; moderate fine subangular blocky structure; hard, firm; slight effervescence; moderately alkaline; clear smooth boundary.

B2—9 to 22 inches; dark grayish brown (2.5Y 4/2) silty clay, grayish brown (2.5Y 5/2) dry; weak medium subangular blocky structure; very hard, very firm; fine accumulations of calcium carbonate; strong effervescence; moderately alkaline; clear smooth boundary.

C1—22 to 35 inches; grayish brown (2.5Y 5/2) silty clay, grayish brown (2.5Y 5/2) dry; massive; very hard, very firm; few calcareous shale fragments; strong effervescence; moderately alkaline; diffuse smooth boundary.

Cr—35 to 44 inches; grayish brown (10YR 5/2) and olive brown (2.5Y 4/4) calcareous clayey shale.

The thickness of the solum ranges from 12 to 30 inches. Depth to shale ranges from 20 to 40 inches. The solum is dominantly moderately alkaline throughout, but in some pedons the upper few inches is mildly alkaline.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is light silty clay or silty clay loam and is 5 to 10 inches thick. The B horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 1 to 3. It is silty clay or heavy silty clay loam. The C1 horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 2 to 4. It is silty clay or clay. It commonly contains fragments of calcareous shale, but it is less than 35 percent coarse fragments.

Kennebec series

The Kennebec series consists of deep, moderately well drained, moderately permeable soils on flood plains. These soils formed in silty alluvium. Slopes range from 0 to 3 percent.

Kennebec soils are similar to Olmitz and Reading soils and are adjacent to those soils and to Chase, Wabash, and Zook soils on the landscape. Chase and Reading soils have argillic horizons. They are in higher positions on the landscape than Kennebec soils. Olmitz soils contain more sand than Kennebec soils. They are on foot slopes. Wabash and Zook soils are darker colored, more clayey, and more poorly drained than Kennebec soils.

Typical pedon of Kennebec silt loam 1,320 feet south and 75 feet east of the northwest corner of sec. 2, T. 7 S., R. 16 E.

Ap—0 to 6 inches; very dark brown (10YR 2/2) silt loam, very dark grayish brown (10YR 3/2) dry; weak fine granular structure; slightly hard, friable; numerous roots; neutral; clear smooth boundary.

A12—6 to 34 inches; very dark brown (10YR 2/2) silt loam, very dark grayish brown (10YR 3/2) dry; moderate medium granular structure; slightly hard, friable; numerous roots; neutral; gradual smooth boundary.

AC—34 to 48 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate fine subangular blocky structure; slightly hard, friable; common roots; slightly acid; diffuse smooth boundary.

C1—48 to 60 inches; dark grayish brown (10YR 4/2) silt loam, grayish brown (10YR 5/2) dry; moderate medium subangular blocky structure; hard, firm; few roots; slightly acid.

The solum and the mollic epipedon are more than 36 inches thick. The solum ranges from medium acid to neutral.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. In some pedons value increases 1 or 2 units with increasing depth. This horizon is typically silt loam, but in some pedons it is silty clay loam. In places very dark grayish brown or dark grayish brown loam or clay loam overwash has been deposited over the Kennebec soils. The upper 40 inches averages between 24 and 30 percent clay. The content of clay varies below a depth of 40 inches.

Martin series

The Martin series consists of deep, moderately well drained, slowly permeable soils on uplands. These soils formed in residuum derived from interbedded silty and clayey shale and clay beds. Slopes range from 3 to 10 percent.

Martin soils are similar to Clime, Pawnee, and Wymore soils and are adjacent to those soils and to Sogn and Vinland soils on the landscape. Clime soils are less than 40 inches deep, and Sogn and Vinland soils are less than 20 inches deep. Pawnee soils contain more sand than Martin soils and formed in glacial till. Wymore soils formed in loess.

Typical pedon of Martin silty clay loam, 3 to 8 percent slopes, 1,100 feet north and 100 feet east of southwest corner of sec. 28, T. 9 S., R. 13 E.

A1—0 to 11 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate fine granular structure; slightly hard, friable; numerous roots; medium acid; gradual smooth boundary.

B1—11 to 17 inches; very dark gray (10YR 3/1) heavy silty clay loam, dark gray (10YR 4/1) dry; moderate fine subangular blocky structure; slightly hard, friable; numerous roots; medium acid; gradual smooth boundary.

B21t—17 to 26 inches; very dark grayish brown (10YR 3/2) silty clay, grayish brown (10YR 5/2) dry; few fine yellowish brown mottles; moderate fine subangular blocky structure; hard, firm; continuous and distinct clay films; few plant roots; medium acid; gradual smooth boundary.

B22t—26 to 40 inches; dark grayish brown (10YR 4/2) silty clay, grayish brown (10YR 5/2) dry; common medium yellowish brown mottles; weak medium subangular blocky structure; continuous and distinct clay films; very hard, very firm; few fine black concretions; very few roots; neutral; diffuse smooth boundary.

B3—40 to 60 inches; dark grayish brown (10YR 4/2) silty clay, grayish brown (10YR 5/2) dry; common fine yellowish brown mottles; massive; very hard, very firm; numerous fine black concretions; very few roots; neutral.

The solum ranges from about 40 to 60 inches in thickness. Depth to shale or clay beds is more than 40 inches. The mollic epipedon ranges from 24 to 36 inches in thickness and extends into the upper part of the argillic horizon. The A and B horizons are medium acid to neutral, and the C horizon is neutral to mildly alkaline.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. The upper part of the B horizon has hue of 10YR, value of 3 or 4, and chroma of 1 or 2. Chroma becomes higher with increasing depth. This horizon is clay or silty clay. Mottles are few in the upper part of the argillic horizon and common in the lower part. The C horizon is variegated clay or silty clay.

Olmitz series

The Olmitz series consists of deep, well drained and moderately well drained soils on alluvial-colluvial fans and concave foot slopes. These soils formed in local loamy alluvium and colluvium derived from glacial till. Permeability is moderate or moderately slow. Slopes range from 2 to 5 percent.

Olmitz soils are similar to Burchard, Chase, Kennebec, Reading, Shelby, and Zook soils and are adjacent to those soils and to Wabash soils on the landscape. Burchard and Shelby soils have a thinner surface layer than Olmitz soils. Chase, Kennebec, Reading, Wabash, and Zook soils contain less sand than Olmitz soils.

Typical pedon of Olmitz clay loam, 2 to 5 percent slopes, 1,320 feet east and 100 feet north of southwest corner of sec. 35, T. 5 S., R. 15 E.

A11—0 to 24 inches; very dark brown (10YR 2/2) clay loam, very dark grayish brown (10YR 3/2) dry; weak and moderate fine granular structure; slightly hard, friable; slightly acid; gradual smooth boundary.

A12—24 to 32 inches; very dark brown (10YR 2/2) clay loam, dark grayish brown (10YR 4/2) dry; moderate fine and medium granular structure; slightly hard, friable; medium acid; diffuse smooth boundary.

B1—32 to 48 inches; dark brown (10YR 3/3) clay loam, brown (10YR 4/3) dry; moderate fine subangular blocky structure; slightly hard, friable; medium acid; gradual smooth boundary.

B2—48 to 60 inches; brown (10YR 4/3) clay loam, brown (10YR 5/3) dry; some darker coatings; weak medium subangular blocky structure; hard, firm; medium acid.

The solum ranges from 40 to more than 60 inches in thickness. Reaction ranges from strongly acid to neutral. In some pedons carbonates are below a depth of 40 inches.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. Recent lighter colored overwash deposits are in some areas. The A horizon is 24 to 32 inches thick. It is dominantly clay loam, but it is loam in some pedons. The B horizon is clay loam. In some pedons value and chroma are 1 or 2 units higher than those of the A horizon. The underlying material is variably colored clay loam.

Pawnee series

The Pawnee series consists of deep, well drained and moderately well drained, slowly permeable soils on uplands. These soils formed in glacial till. Slopes range from 1 to 7 percent.

Pawnee soils are similar to Martin and Wymore soils and are adjacent to those soils and to Burchard, Clime, and Shelby soils on the landscape. Burchard and Shelby soils are less clayey than Pawnee soils. Martin and Wymore soils contain less sand than Pawnee soils. Martin soils formed in residuum derived from shale or clay beds, and Wymore soils formed in loess. Clime soils are less than 40 inches deep.

Typical pedon of Pawnee clay loam, 3 to 7 percent slopes (fig. 9), 400 feet south and 100 feet east of northwest corner of sec. 17, T. 7 S., R. 13 E.

A1—0 to 10 inches; black (10YR 2/1) clay loam, dark gray (10YR 4/1) dry; moderate fine granular structure; slightly hard, friable; medium acid; gradual smooth boundary.

B1—10 to 16 inches; very dark gray (10YR 3/1) clay loam, dark gray (10YR 4/1) dry; some very dark gray (10YR 3/1) dry coatings; weak very fine subangular blocky structure parting to moderate or strong fine granular; slightly hard, friable; medium acid; clear gradual boundary.

B21t—16 to 24 inches; dark brown (10YR 4/3) clay, brown (10YR 5/3) dry, dark brown (10YR 3/3) crushed and mixed; many fine distinct reddish brown and dark gray mottles; moderate fine subangular blocky structure; thin continuous clay films; very hard, very firm; few sand grains; slightly hard; gradual smooth boundary.

B22t—24 to 40 inches; dark brown (10YR 4/3) clay, brown (10YR 4/3) dry; common medium faint yellowish brown mottles; weak medium subangular blocky structure, nearly massive; thin continuous clay films; very hard, very firm; few small pebbles; few black concretions; neutral; clear smooth boundary.

B3—40 to 52 inches; yellowish brown (10YR 5/6) clay, yellowish brown (10YR 5/6) dry; some darker coatings; massive; very hard, very firm; numerous dark stains; few accumulations of calcium carbonate; moderately alkaline; clear smooth boundary.

C—52 to 60 inches; yellowish brown (10YR 5/4) clay, light yellowish brown (10YR 6/4) dry; massive; very hard, very firm; numerous dark stains; few accumulations of calcium carbonate; moderately alkaline.

The solum ranges from 36 to 60 inches in thickness. Reaction ranges from medium acid to neutral in the upper part of the solum and from neutral to moderately alkaline in the lower part of the solum and in the C horizon. The mollic epipedon is 10 to 18 inches thick.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. The argillic horizon has hue of 10YR, value of 3 or 4, and chroma of 2 or 3. Chroma and value become higher with increasing depth. This horizon is more than 40 percent clay. It is mottled. In some pedons accumulations of calcium carbonate are below a depth of 30 inches.

Reading series

The Reading series consists of deep, well drained, moderately slowly permeable soils on terraces or high bottoms. These soils formed in thick deposits of silty alluvium. Slopes are 0 to 2 percent.

Reading soils are similar to Chase, Kennebec, Olmitz, and Zook soils and are adjacent to those soils and to Wabash soils on the landscape. Chase, Wabash, and Zook soils have a fine textured control section and are darker colored than Reading soils. Kennebec, Wabash, and Zook soils do not have argillic horizons. Olmitz soils have a fine-loamy control section.

Typical pedon of Reading silt loam 700 feet west and 100 feet north of southeast corner of sec. 30, T. 9 S., R. 14 E.

Ap—0 to 8 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak, very fine granular structure; slightly hard, friable; medium acid; clear smooth boundary.

A12—8 to 17 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate fine and medium granular structure; slightly hard, friable; medium acid; gradual smooth boundary.

B1—17 to 21 inches; very dark brown (10YR 2/2) silty clay loam, very dark grayish brown (10YR 3/2) dry; moderate fine subangular blocky structure; slightly hard, friable; medium acid; gradual smooth boundary.

B21t—21 to 32 inches; very dark grayish brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; thin dark coatings; moderate fine subangular blocky structure; hard, firm; medium acid; gradual smooth boundary.

B22t—32 to 50 inches; dark brown (10YR 4/3) silty clay loam, brown (10YR 5/3) dry; thin patchy dark coatings; weak medium subangular blocky structure; hard, firm; medium acid; gradual smooth boundary.

B3—50 to 60 inches; dark brown (10YR 4/3) silty clay loam, brown (10YR 5/3) dry; few patchy dark coatings; few fine yellowish brown mottles; massive; very hard, very firm; slightly acid.

The thickness of solum ranges from 40 to more than 60 inches. The mollic epipedon is more than 24 inches thick. The A and B horizons are medium acid or slightly acid, and the C horizon, below a depth of 40 inches, is moderately alkaline in some pedons.

The A horizon has hue of 10YR and value and chroma of less than 3. It is silt loam or silty clay loam. The B horizon has hue of 10YR or 7.5YR and value and chroma of 2 to 4. The clay content is between 28 and 35 percent. The C horizon is silty clay loam or light silty clay. It has hue of 10YR or 7.5YR, value 4 or 5, and chroma 2 to 4. In some pedons faint mottles are below a depth of 40 inches. In some segregated lime is below a depth of 40 inches.

Shelby series

The Shelby series consists of deep, moderately well drained, moderately slowly permeable soils on uplands. These soils formed in glacial till that is 5 to 12 feet thick. Slopes range from 4 to 25 percent.

Shelby soils are similar to Burchard and Olmitz soils and are commonly adjacent to those soils and to Pawnee and Wymore soils on the landscape. Burchard soils have streaks or pockets of soft lime between depths of 15 and 30 inches. Pawnee and Wymore soils contain more clay in the argillic horizon than Shelby soils. Also, they are less sloping and higher lying. Olmitz soils have a thicker surface layer than Shelby soils and contain more sand. They are below those soils on concave foot slopes.

Typical pedon of Shelby clay loam (fig. 10), in an area of Burchard-Shelby clay loams, 7 to 12 percent slopes, 550 feet east and 50 feet south of northwest corner of sec. 13, T. 6 S., R. 14 E.

A1—0 to 15 inches; very dark brown (10YR 2/2) clay loam, very dark grayish brown (10YR 3/2) dry; moderate fine granular structure; slightly hard, friable; few pebbles and sand grains; neutral; gradual smooth boundary.

B21t—15 to 20 inches; dark brown (10YR 4/3) clay loam, brown (10YR 5/3) dry; moderate fine granular structure; slightly hard, friable; thin clay films; few pebbles and sand grains; medium acid; gradual smooth boundary.

B22t—20 to 32 inches; brown (10YR 5/3) clay loam, pale brown (10YR 6/3) dry; few fine yellowish brown mottles; moderately fine and medium subangular blocky structure; hard, firm; continuous clay films; few pebbles and sand grains; medium acid; diffuse smooth boundary.

B23t—32 to 43 inches; brown (10YR 5/3) clay loam, pale brown (10YR 6/3) dry; numerous coarse yellowish brown mottles; moderate medium subangular blocky structure; hard, firm; thin continuous clay films; few pebbles and sand grains; medium acid; clear smooth boundary.

C—43 to 60 inches; yellowish brown (10YR 5/4) clay loam, yellowish brown (10YR 5/4) dry; some gray spots and dark staining; massive; hard, firm; few pebbles; numerous accumulations of calcium carbonate; moderately alkaline.

The solum ranges from 30 to 60 inches in thickness. The A and B horizons are medium acid or strongly acid, and the C horizon ranges from medium acid to moderately alkaline. In some pedons accumulations of calcium carbonate are below a depth of 30 inches.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is dominantly clay loam, but in some pedons it is loam or silt loam. The argillic horizon has hue of 10YR, value of 4 or 5, and chroma of 3 to 6. It is clay loam averaging between 32 and 35 percent clay. Some pedons have thin layers that are more clayey. Mottles are generally evident below a depth of 20 inches. In some pedons sand and or gravel pockets are below a depth of 30 inches. The C horizon is coarsely mottled, dark yellowish brown, yellowish brown, or light brownish gray heavy clay loam.

Sogn series

The Sogn series consists of shallow, somewhat excessively drained, moderately permeable soils on uplands. These soils formed in residuum derived from the underlying limestone. Slopes range from 5 to 15 percent.

Sogn soils are similar to Clime and Vinland soils and are commonly adjacent to those soils and to Martin soils on the landscape. Clime and Martin soils are not underlain by bedrock within a depth of 20 inches. The paralithic contact in Vinland soils is within a depth of 20 inches.

Typical pedon of Sogn silty clay loam, in an area of Clime-Sogn complex, 5 to 20 percent slopes, 1,620 feet north and 100 feet west of southeast corner of sec. 16, T. 9 S., R. 13 E.

A1—0 to 12 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak fine granular structure; slightly hard, friable; lower 6 inches is about 5 to 10 percent limestone fragments; mildly alkaline; abrupt smooth boundary.

R—12 inches; limestone.

The thickness of solum and the depth to hard limestone range from 4 to 20 inches. Reaction is slightly acid, neutral, or moderately alkaline. The A horizon has hue of 10YR, value 2 or 3, and chroma of 1 or 2. The content of limestone fragments ranges from about 4 to 35 percent of the soil mass.

Vinland series

The Vinland series consists of shallow, somewhat excessively drained, moderately permeable soils on uplands. These soils formed in residuum derived from interbedded sandstone and shale. Slopes range from 5 to 40 percent.

Vinland soils are similar to Clime and Sogn soils and are commonly adjacent to Martin and Sogn soils on the landscape. Clime and Martin soils are not underlain by bedrock within a depth of 20 inches. Sogn soils formed in residuum derived from limestone and have a lithic contact.

Typical pedon of Vinland silty clay loam, in an area of Vinland-Sogn complex, 5 to 20 percent slopes, 75 feet east and 50 feet south of northwest corner of sec. 34, T. 9 S., R. 16 E.

A1—0 to 5 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate medium and fine granular structure; hard, friable; slightly acid; gradual smooth boundary.

B2—5 to 11 inches; very dark brown (10YR 2/2) silty clay loam, very dark grayish brown (10YR 3/2) dry; weak medium and fine subangular blocky structure; hard, firm; few small shale and siltstone fragments; slightly acid; gradual smooth boundary.

C—11 to 17 inches; mixed grayish brown (2.5Y 5/2) and dark grayish brown (10YR 4/2) silty clay loam, light yellowish brown (2.5Y 6/4) and brown (10YR 5/3) dry; weak fine blocky structure grading to massive; hard, friable; common small shale fragments; slightly acid; clear wavy boundary.

C—17 inches; weathered interbedded silty and sandy shale.

The solum and the depth to shale are 10 to 20 inches. Reaction ranges from slightly acid to mildly alkaline. The texture is silty clay loam, silt loam, or loam. The content of shale fragments is, by volume, less than 15 percent. It increases with increasing depth.

The A horizon has hue of 10YR, value 2 or 3, and chroma 1 or 2. It is 4 to 11 inches thick. The B horizon has hue of 10YR, value of 2 to 5, and chroma 2 to 4. The underlying shale is silty to sandy.

Wabash series

The Wabash series consists of deep, very poorly drained, very slowly permeable soils in low or depressional areas on large flood plains. These soils formed in fine textured alluvium. Slopes are 0 to 2 percent; they are mostly less than 1 percent.

Wabash soils are similar to Zook soils and are commonly adjacent to those soils and to Chase, Kennebec, Olmitz, and Reading soils on the landscape. Chase and Reading soils have argillic horizons. Kennebec and Reading soils have a less clayey control section than Wabash soils, Olmitz soils contain more sand, and Chase and Zook soils have a less clayey surface layer.

Typical pedon of Wabash silty clay 1,540 feet east and 50 feet north of southwest corner of sec. 27, T. 9 S., R. 13 E.

A1—0 to 24 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; very hard, firm; medium acid; diffuse smooth boundary.

B1g—24 to 42 inches; very dark gray (10YR 3/1) silty clay, gray (10YR 5/1) dry; weak medium subangular blocky structure; very hard, very firm; medium acid; diffuse smooth boundary.

B2g—42 to 60 inches; dark grayish brown (2.5Y 4/2) silty clay, grayish brown (2.5Y 5/2) dry; few fine distinct yellowish brown mottles; weak fine subangular blocky structure; very hard, very firm; mildly alkaline.

The solum ranges from 40 to more than 60 inches in thickness. The upper part of the solum ranges from medium acid to neutral and the lower part from slightly acid to moderately alkaline. In some pedons carbonates are below a depth of 40 inches.

The texture is dominantly silty clay. In some pedons, however, the A horizon is silty clay loam less than 12 inches thick. The A horizon and the upper part of the B horizon have hue of 10YR, value of 2 or 3, and chroma of 1 or 2. Color value of the lower part of the B horizon is 1 or 2 units higher than that of the upper part.

Wymore series

The Wymore series consists of deep, moderately well drained and well drained, slowly permeable soils on uplands. These soils formed in silty loess. Slopes range from 1 to 5 percent.

Wymore soils are similar to Martin and Pawnee soils and are adjacent to those soils and to Burchard and Shelby soils on the landscape. Burchard, Pawnee, and Shelby soils contain more sand than Wymore soils and formed in glacial till. Martin soils formed in residuum derived from shale or clay beds. Burchard and Shelby soils have a less clayey argillic horizon than Wymore soils.

Typical pedon of Wymore silty clay loam, 1 to 3 percent slopes, 1,600 feet west and 100 feet south of northeast corner of sec. 18, T. 6 S., R. 13 E.

A1—0 to 6 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; moderate medium granular structure; friable; slightly acid; clear smooth boundary.

B1—6 to 10 inches; very dark brown (10YR 2/2) silty clay loam, dark gray (10YR 4/1) dry; moderate fine and very fine blocky structure; firm; gray silt coatings on ped faces; medium acid; clear smooth boundary.

B21t—10 to 18 inches; very dark grayish brown (10YR 3/2) silty clay, grayish brown (10YR 5/2) dry; moderate medium and fine blocky structure; very firm; gray silt coatings on vertical ped faces; few fine iron and manganese concretions; slightly acid; gradual smooth boundary.

B22t—18 to 32 inches; dark grayish brown (10YR 4/2) silty clay, grayish brown (10YR 5/2) dry; few fine distinct strong brown (7.5YR 5/6) and few faint gray (10YR 5/1) mottles; moderate medium and fine blocky structure; very firm; films on ped faces; few fine iron and manganese concretions; neutral; gradual smooth boundary.

B3—32 to 43 inches; dark grayish brown (10YR 4/2) silty clay loam, grayish brown (10YR 5/2) dry; common fine and medium distinct strong brown (7.5YR 5/6) mottles; weak medium and fine blocky structure; firm; common fine iron and manganese concretions; few calcium carbonate concretions; mildly alkaline; gradual smooth boundary.

C1—43 to 60 inches; mixed brown (10YR 4/3), grayish brown (10YR 5/2), and pale brown (10YR 6/3) silty clay loam, light brownish gray (10YR 6/2) dry; massive; friable; common fine iron and manganese concretions and stains; mildly alkaline.

The thickness of the solum ranges from 36 to 50 inches. Calcareous concretions are below a depth of 30 inches. The solum ranges from medium acid in the upper part to neutral or moderately alkaline in the lower part. The mollic epipedon is 12 to 18 inches thick and extends into the argillic, or B2t, horizon.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. The thickness of the A horizon combined with that of the B1 horizon ranges from about 4 to 15 inches. The argillic horizon is silty clay that is about 40 to 45 percent clay. The upper part of the B2t horizon has hue of 10YR or 2.5Y, value of 2 to 4, and chroma of 2 to 4. Mottles are evident in the lower part of the argillic horizon. A buried horizon is below a depth of 30 inches in some pedons.

Zook series

The Zook series consists of deep, poorly drained, slowly permeable soils on flood plains. These soils formed in fine textured alluvium. Slopes are 0 to 2 percent.

Zook soils are similar to Chase, Olmitz, Reading, and Wabash soils and are adjacent to those soils and to Kennebec soils on the landscape. Chase and Reading soils have argillic horizons. Kennebec and Reading soils have a less clayey control section than Zook soils. Olmitz soils contain more sand than Zook soils, and Wabash soils have a more clayey surface layer.

Typical pedon of Zook silty clay loam 450 feet east and 100 feet north of the southwest corner of sec. 35, T. 6 S., R. 15 E.

A1—0 to 18 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate medium granular structure; weak fine granular structure in the upper 6 inches; hard, firm; neutral; gradual smooth boundary.

A3—18 to 38 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; few fine distinct grayish brown (2.5Y 5/2) mottles; weak medium subangular blocky structure; nearly massive; very hard, very firm; neutral; diffuse smooth boundary.

Bg—38 to 60 inches; dark gray (10YR 4/1) silty clay, gray (10YR 5/1) dry; few fine distinct strong brown (7.5YR 5/6) mottles; few fine black stains; weak medium subangular blocky structure; extremely hard, extremely firm; neutral.

The solum is 36 to more than 60 inches thick. Reaction ranges from medium acid to mildly alkaline. The mollic epipedon ranges from 36 to 50 inches in thickness.

The A horizon is 26 to 40 inches thick. The upper part is silty clay loam 12 to 24 inches thick. The lower part is silty clay. The A horizon ranges from 32 to 42 percent clay. It has hue of 10YR, value of 3 or less, and chroma of 1 or less. Color value of the B horizon is 1 or 2 units higher than that of the A horizon. The clay content ranges from 38 to 46 percent.

Classification of the soils

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965. Readers interested in further details about the system should refer to the latest literature available (*7*, *10*).

The system of classification has six categories. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. In this system the classification is based on the different soil properties that can be observed in the field or those that can be inferred either from other properties that are observable in the field or from the combined data of soil science and other disciplines. The properties selected for the higher categories are the result of soil genesis or of factors that affect soil genesis. In table 18, the soils of the survey area are classified according to the system. Categories of the system are discussed in the following paragraphs.

ORDER. Ten soil orders are recognized as classes in the system. The properties used to differentiate among orders are those that reflect the kind and degree of dominant soil-forming processes that have taken place. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders based primarily on properties that influence soil genesis and are important to plant growth or that are selected to reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Udoll (*Ud*, meaning humid, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of expression of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and a prefix that suggests something about the properties of the soil. An example is Argiudolls (*Argi*, meaning argillic horizons, plus *udoll*, the suborder of Mollisols that have a udic moisture regime).

SUBGROUP. Each great group may be divided into three subgroups: the central (typic) concept of the great groups, which is not necessarily the most extensive subgroup; the intergrades, or transitional forms to other orders, suborders, or great groups; and the extragrades, which have some properties that are representative of the great groups but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that is thought to typify the great group. An example is Typic Argiudolls.

FAMILY. Families are established within a subgroup on the basis of similar physical and chemical properties that affect management. Among the properties considered in horizons of major biological activity below plow depth are particle-size distribution, mineral content, temperature regime, thickness of the soil penetrable by roots, consistence, moisture equivalent, soil slope, and permanent cracks. A family name consists of the name of a subgroup and a series of adjectives. The adjectives are the class names for the soil properties used as family differentiae. An example is fine-loamy, mixed, mesic Typic Argiudolls.

SERIES. The series consists of soils that formed in a particular kind of material and have horizons that, except for texture of the surface soil or of the underlying substratum, are similar in differentiating characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineral and chemical composition.

Formation of the soils

Soil forms through the physical and chemical weathering of deposited or accumulated geologic material. The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the parent material; (2) the climate under which the soil material has accumulated and existed since accumulation; (3) the plant and animal life on and in the soil; (4) the relief, or lay of the land; and (5) the length of time the forces of soil formation have acted on the soil material.

Climate and plant and animal life, chiefly plants, are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it to a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material also affects the kind of soil profile that forms and, in extreme cases, determines it almost entirely. Finally, time is needed for changing the parent material into a soil. The length of time varies, but some time is always required for differentiation of soil horizons. Usually, a long time is required for distinct horizons to form.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four. Many of the processes of soil formation are unknown. The following paragraphs relate the factors of soil formation to the soils in the survey area.

Parent material

Parent material is the unconsolidated material in which soils form. It forms as a result of the weathering of rocks through the processes of freezing and thawing, as the result of soil blowing, and as a result of the grinding of rocks by rivers and glaciers. It also forms as a result of chemical processes.

The soils of Jackson County formed in material derived from four primary sources (*11*): (1) Pennsylvanian and Permian limestone and shale, (2) Kansan glacial till, (3) loess, and (4) recent alluvium.

Pennsylvanian and Permian limestone and shale crops out along steep slopes adjacent to drainageways. The limestone ranges from the Rulo limestone in the southeast corner of the county to the Threemile limestone in a few small areas in the extreme western part. In these few areas, the limestone is weathered and only a bed of irregular chert nodules remains. Residuum weathered from the bedrock is the parent material of Clime, Martin, Sogn, and Vinland soils.

Some of the shale is sufficiently sandy to be a source of ground water. Most of the limestone, however, produces meager supplies of water.

Kansas glacial till was deposited over bedrock by the Kansan glacier, which contained silt, clay, sand, and gravel. It is the parent material of Burchard, Pawnee, and Shelby soils. These soils vary widely in character and productivity. Fertility ranges from high to low. Some of these soils contain much organic matter; others, little. Burchard and Shelby soils are well drained and moderately well drained. Pawnee soils have a slowly permeable subsoil.

Long after the Kansan till was deposited, layers of loess, or wind-blown silt, were deposited. Apparently, much of the loess was blown in from the valley of the Missouri River. As the distance from the river increases, the depth of loess is less and the texture is finer. The wind-blown loess contains no grit or pebbles. Wymore soils formed in loess. They have a slowly permeable subsoil.

The alluvium in the county has been deposited in recent time. It is the most variable of all the parent material in the county. Variations in the texture of the alluvial sediments and in drainage are responsible for most of the differences among the soils formed in alluvium.

Alluvium recently deposited on the bottom of streams is the parent material of Chase, Kennebec, Olmitz, Reading, Wabash, and Zook soils. Kennebec and Reading soils formed in friable silty material deposited by water that was moving fairly rapidly. Wabash and Zook soils formed in clayey alluvium deposited by less rapidly moving water. In some areas of Chase and Olmitz soils next to the uplands, colluvium was mixed with the alluvium.

Climate

Climate influences the physical and chemical processes of weathering and the biological forces at work in the soil material. Generally, the soil-forming processes become more active as the soil warms, if the moisture is adequate, but they are limited by either inadequate moisture or excess moisture.

Climate is uniform throughout the county. The seasonal variations in temperature are wide. Most of the rainfall occurs in spring and fall, when a large proportion of the land is freshly cultivated and highly susceptible to sheet and gully erosion caused by uncontrolled runoff.

The effect of climate is modified by topography. The amount of rainfall that soaks into the soil and the amount that runs off depend partly on slope. The larger the amount of water that percolates through the soil, the more the soil is leached. Also, more of the clay particles are transported into the subsoil. Rainfall stimulates the growth of plants, which, in turn, promotes the accumulation of organic matter and darkens the surface layer.

Plant and animal life

Living organisms, including plant and animal life, live on and in the soils and contribute to the development of a soil profile.

The climate of Jackson County favors the growth of tall prairie grasses, such as big bluestem, little bluestem, switchgrass, and indiangrass. Some trees grow along streams.

Plants provide organic matter, which improves soil structure. They also provide a cover for the soil, which reduces runoff, improves the rate of water intake, and reduces the loss of moisture through evaporation. The nature of the soil material in a climatic region determines the kind of vegetation. The fibrous grass roots provide organic matter and darken the surface layer in most prairie soils. Plant residue and channels made by plant roots improve water percolation and aeration. Plantlife affects animal life by providing favorable conditions for soil organisms and food and cover for burrowing animals.

Soil organisms, such as bacteria and fungi, help in the weathering of rocks or shale and the decomposition of organic matter. They influence the chemical, physical, and biological process of soil formation. Worms and larger burrowing animals modify the soil profile.

Relief

Relief is the gradient, length, and shape of slopes and their pattern. It influences soil formation through its effect on drainage, runoff, and erosion. The movement of water on the surface and in the soil is affected by relief. The landscape of the county is one of gently sloping to steep uplands that have been thoroughly dissected by numerous small streams. Nearly level to depressional areas are adjacent to the major streams.

Steep slopes can increase runoff, reduce the amount of moisture that enters the soil, and increase the risk of erosion. As a result, the steeper soils are thinner and have a less well developed profile. Vinland soils are an example.

On gently sloping and sloping soils, water runs off slowly and more water soaks into the soil. The amount of water that penetrates the soil depends on the permeability. Many of the gently sloping and moderately sloping soils in Jackson County have well developed profiles with contrasting horizons that reflect the effects of water in the leaching of clay particles and soil minerals. Pawnee, Martin, and Wymore soils are examples.

Moderately sloping and moderately steep soils that formed in permeable parent material have moderately developed profiles. Burchard and Shelby soils are examples.

Time

Time is required for parent material to be changed into a soil. Maturity of soils is expressed in terms of the degree of profile development. Soils that formed in parent material of the same age can differ in maturity. Those that show little or no evidence of profile development are immature, and those that have well expressed horizons are mature. The degree of profile development depends on the interaction of all the soil-forming factors.

The soils in Jackson County range from immature to mature. Those on the bottom land are subject to varying degrees of flooding and receive varying amounts of new sediments when they are flooded. These soils generally have a thick, dark colored surface layer. The continual addition of sediments has helped to retard soil formation. Kennebec soils are an example of immature soils on bottom land. Martin, Pawnee, and Wymore soils, which have distinct horizons, are considered mature.

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Glossary

ABC soil. A soil having an A, a B, and a C horizon.

AC soil. A soil having only an A and a C horizon. Commonly such soil formed in recent alluvium or on steep rocky slopes.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim. An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	More than 9

Bedding system. Plowing or grading the surface into a series of elevated beds separated by shallow ditches to implement surface drainage.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bottom land. The normal flood plain of a stream, subject to frequent flooding.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Calcareous soil. A soil containing enough calcium carbonate (commonly with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid. A soil having measurable amounts of calcium carbonate or magnesium carbonate.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coat, clay skin.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the bases of steep slopes.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures is difficult.

Complex, soil. A map unit of two or more kinds of soil occurring in such an intricate pattern that they cannot be shown separately on a soil map at the selected scale of mapping and publication.

Compressible. Excessive decrease in volume of soft soil under load.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Contour stripcropping (or contour farming). Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is 40 or 80 inches (1 or 2 meters).

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Crop residue management. Maintaining stubble, stalks, and other crop residue on the surface to control erosion and soil blowing, conserve water, and decrease evaporation.

Crop rotation. A planned sequence of crops grown in regular recurring succession on the same land, as contrasted with continuous culture of one crop and with a haphazard sequence of different crops.

Decreasers. The most heavily grazed climax range plants. Because they are the most palatable, they are the first to be destroyed by overgrazing.

Deferred grazing. A delay in grazing until range plants have reached a specified stage of growth. Grazing is deferred in order to increase the vigor of forage and to allow desirable plants to produce seed. Contrasts with continuous grazing and rotation grazing.

Depth to rock. Bedrock at a depth that adversely affects the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients, as for example in "hillpeats" and "climatic moors."

Drainage, surface. Runoff, or surface flow of water, from an area.

Erosion. The wearing away of the land surface by running water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes a bare surface.

Excess fines. Excess silt and clay. The soil does not provide a source of gravel or sand for construction purposes.

Favorable. Favorable soil features for the specified use.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fine textured (heavy textured) soil. Sandy clay, silty clay, and clay.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flooding. The temporary covering of soil with water from overflowing streams, runoff from adjacent slopes, and tides. Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs on an average of once or less in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; *November-May*, for example, means that flooding can occur during the period November through May. Water standing for short periods after rainfall or commonly covering swamps and marshes is not considered flooding.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Frost action. Freezing and thawing of soil moisture. Frost action can damage structures and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial till (geology). Unassorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Green manure (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Habitat. The natural abode of a plant or animal; refers to the kind of environment in which a plant or animal normally lives, as opposed to the range or geographical distribution.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. The major horizons of mineral soil are as follows:

O horizon.—An organic layer, fresh and decaying plant residue, at the surface of a mineral soil.

A horizon.—The mineral horizon, formed or forming at or near the surface, in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon most of which was originally part of a B horizon.

A2 horizon.—A mineral horizon, mainly a residual concentration of sand and silt high in content of resistant minerals as a result of the loss of silicate clay, iron, aluminum, or a combination of these.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or a combination of these; (2) by prismatic or blocky structure; (3) by redder or browner colors than those in the A horizon; or (4) by a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that from which the solum is presumed to have formed. If the material is known to differ from that in the solum, the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered, but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Increasers. Species in the climax vegetation that increase in amount as the more desirable plants are reduced by close grazing. Increasers commonly are the shorter plants and the less palatable to livestock.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Invaders. On range, plants that encroach into an area and grow after the climax vegetation has been reduced by grazing. Generally, invader plants are those that follow disturbance of the surface.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. Inadequate strength for supporting loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous areas. Areas that have little or no natural soil, are too nearly inaccessible for orderly examination, or cannot otherwise be feasibly classified.

Moderately coarse textured (moderately light textured) soil. Sandy loam and fine sandy loam.

Moderately fine textured (moderately heavy textured) soil. Clay loam, sandy clay loam, and silty clay loam.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few*, *common*, and *many;* size—*fine*, *medium*, and *coarse;* and contrast—*faint*, *distinct*, and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse* more than 15 millimeters (about 0.6 inch).

Munsell notation. A designation of color by degrees of the three single variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3.

Organic matter. Plant and animal material, in or on the soil, in all stages of decomposition. Readily decomposed organic matter is often distinguished from the more stable forms that are past the stage of rapid decomposition.

Parent material. The great variety of unconsolidated organic and mineral material in which soil forms. Consolidated bedrock is not yet parent material by this concept.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly. The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality that enables the soil to transmit water or air, measured as the number of inches per hour that water moves through the soil. Terms describing permeability are *very slow* (less than 0.06 inch), *slow* (0.06 to 0.20 inch), *moderately slow* (0.2 to 0.6 inch), *moderate* (0.6 to 2.0 inches), *moderately rapid* (2.0 to 6.0 inches), *rapid* (6.0 to 20 inches), and *very rapid* (more than 20 inches).

Phase, soil. A subdivision of a soil series or other unit in the soil classification system based on differences in the soil that affect its management. A soil series, for example, may be divided into phases on the basis of differences in slope, stoniness, thickness, or some other characteristic that affects management. These differences are too small to justify separate series.

pH value. (See Reaction, soil). A numerical designation of acidity and alkalinity in soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from a semisolid to a plastic state.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Range (or rangeland). Land that, for the most part, produces native plants suitable for grazing by livestock; includes land supporting some forest trees.

Range condition. The health or productivity of forage plants on a given range, in terms of the potential productivity under normal climate and the best practical management. Condition classes generally recognized are—*excellent*, *good*, *fair*, and *poor*. The classification is based on the percentage of original, or assumed climax vegetation on a site, as compared to what has been observed to grow on it when well managed.

Range site. An area of range where climate, soil, and relief are sufficiently uniform to produce a distinct kind and amount of native vegetation.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Residuum (residual soil material). Unconsolidated, weathered, or partly weathered mineral material that accumulates over disintegrating rock.

Rooting depth. Shallow root zone. The soil is shallow over a layer that greatly restricts roots. See Root zone.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged in stream channels from a drainage area. The water that flows off the land surface without sinking in is called surface runoff; that which enters the ground before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Seepage. The rapid movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils, formed from a particular type of parent material, having horizons that, except for the texture of the A or surface horizon, are similar in all profile characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineralogical and chemical composition.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slick spot. Locally, a small area of soil having a puddled, crusted, or smooth surface and an excess of exchangeable sodium. The soil is generally silty or clayey, is slippery when wet, and is low in productivity.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slow intake. The slow movement of water into the soil.

Soil. A natural, three-dimensional body at the earth's surface that is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows: *very coarse sand* (2.0 millimeters to 1.0 millimeter); *coarse sand* (1.0 to 0.5 millimeter); *medium sand* (0.5 to 0.25 millimeter); *fine sand* (0.25 to 0.10 millimeter); *very fine sand* (0.10 to 0.05 millimeter); *silt* (0.05 to 0.002 millimeter); and *clay* (less than 0.002 millimeter).

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in mature soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristics of the soil are largely confined to the solum.

Stratified. Arranged in strata, or layers. The term refers to geologic material. Layers in soils that result from the processes of soil formation are called horizons; those inherited from the parent material are called strata.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates that are separated from adjoining aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Technically, the A2 horizon. Generally refers to a leached horizon lighter in color and lower in content of organic matter than the overlying surface layer.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that it can soak into the soil or flow slowly to a prepared outlet without harm. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea. A stream terrace is frequently called a second bottom, in contrast with a flood plain, and is seldom subject to overflow. A marine terrace, generally wide, was deposited by the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt, silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer. Otherwise suitable soil material too thin for the specified use.

Tilth, soil. The condition of the soil, especially the soil structure, as related to the growth of plants. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable struc-

ture. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Topsoil (engineering). Presumably a fertile soil or soil material, or one that responds to fertilization, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Water table. The upper limit of the soil or underlying rock material that is wholly saturated with water.

Water table, apparent. A thick zone of free water in the soil. An apparent water table is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

Water table, artesian. A water table under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole.

Water table, perched. A water table standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Illustrations

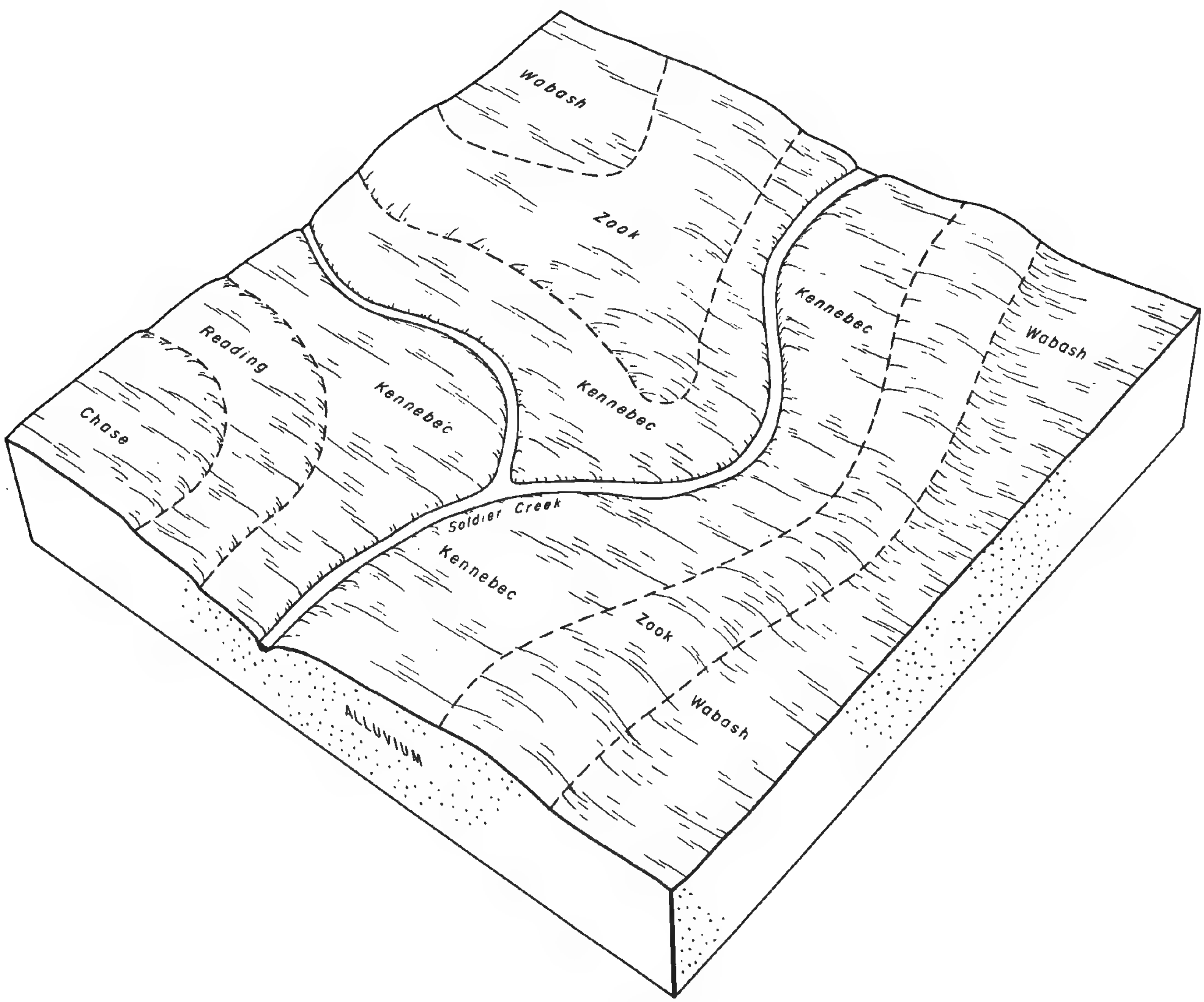

Figure 1.—Pattern of soils and underlying material in the Kennebec-Zook-Wabash map unit.

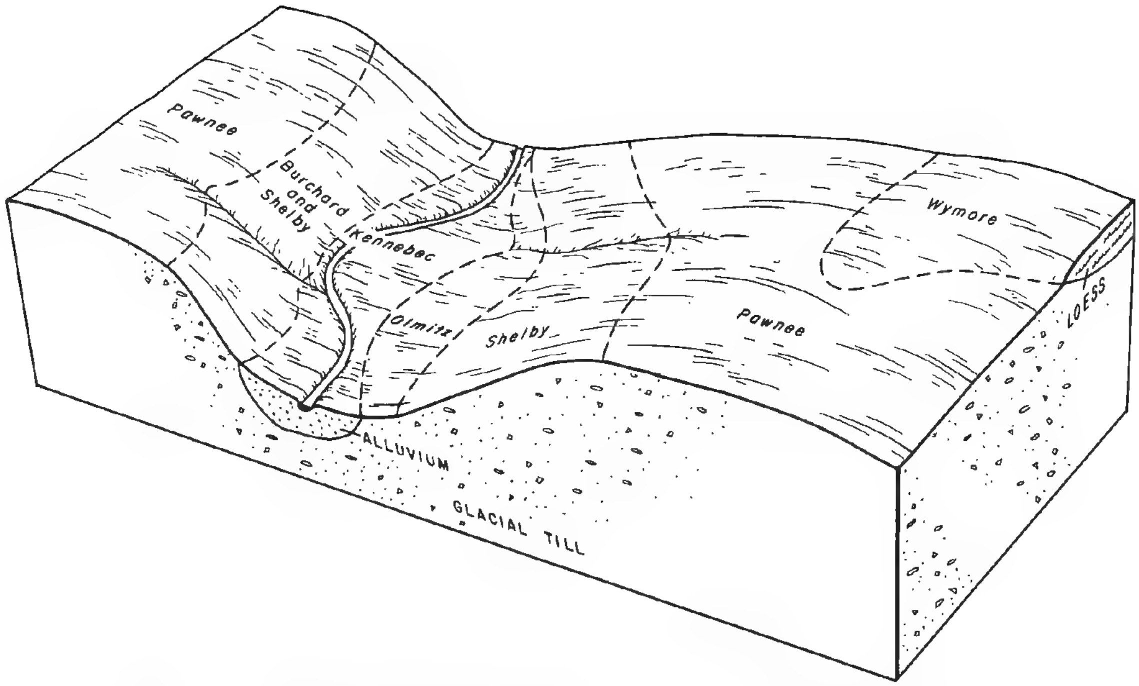

Figure 2.—Pattern of soils and underlying material in the Pawnee-Shelby-Burchard map unit.

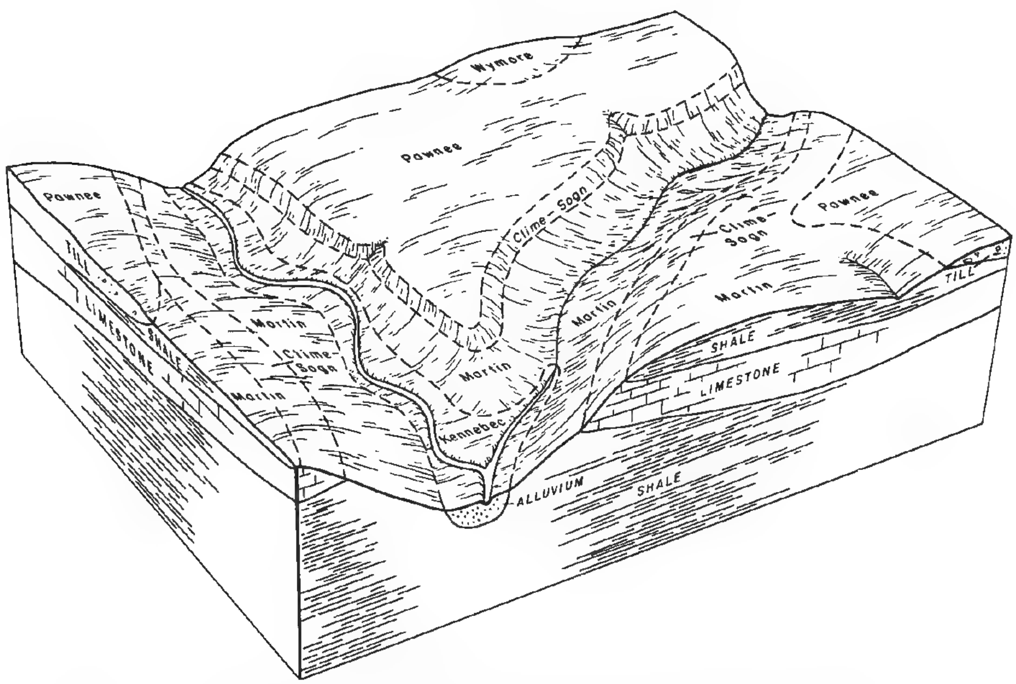

Figure 3.—Pattern of soils and underlying material in the Martin-Pawnee-Sogn map unit.

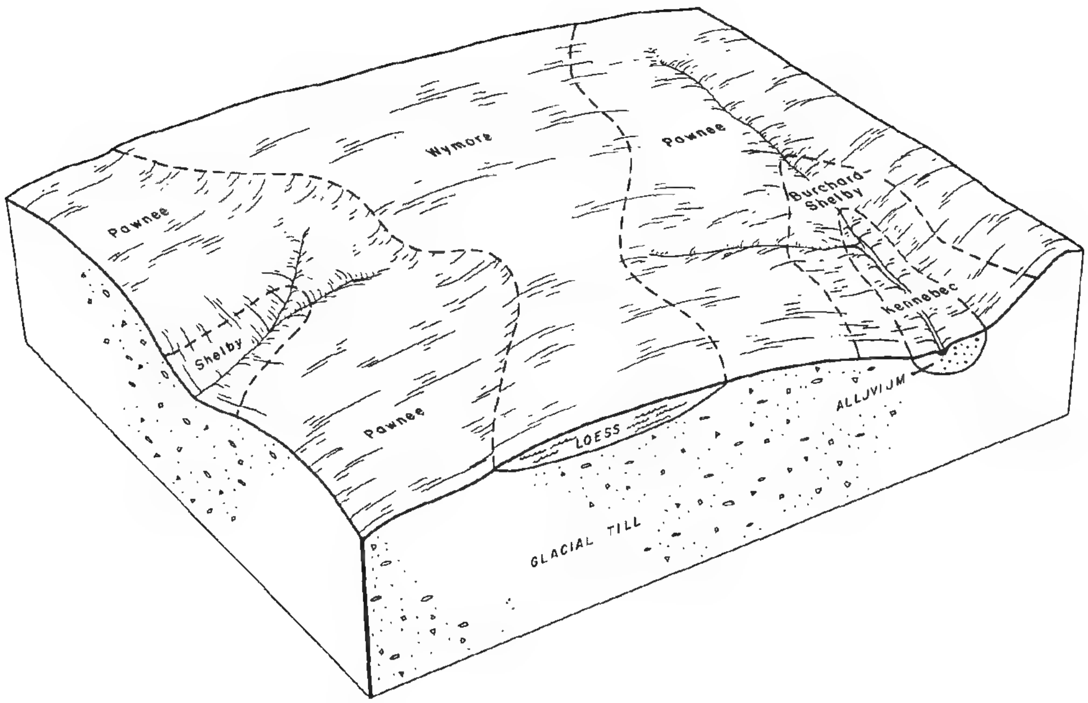

Figure 4.—Pattern of soils and underlying material in the Pawnee-Wymore map unit.

Figure 5.—Sorghum on Martin silty clay loam, 3 to 8 percent slopes. The field is terraced and farmed on the contour.

Figure 6.—Field that is terraced and farmed on the contour on Martin silty clay loam, 3 to 8 percent slopes. Wheat stubble is on the right; grain sorghum, on the left.

Figure 7.—Grass on Loamy Upland range site after deferred grazing.

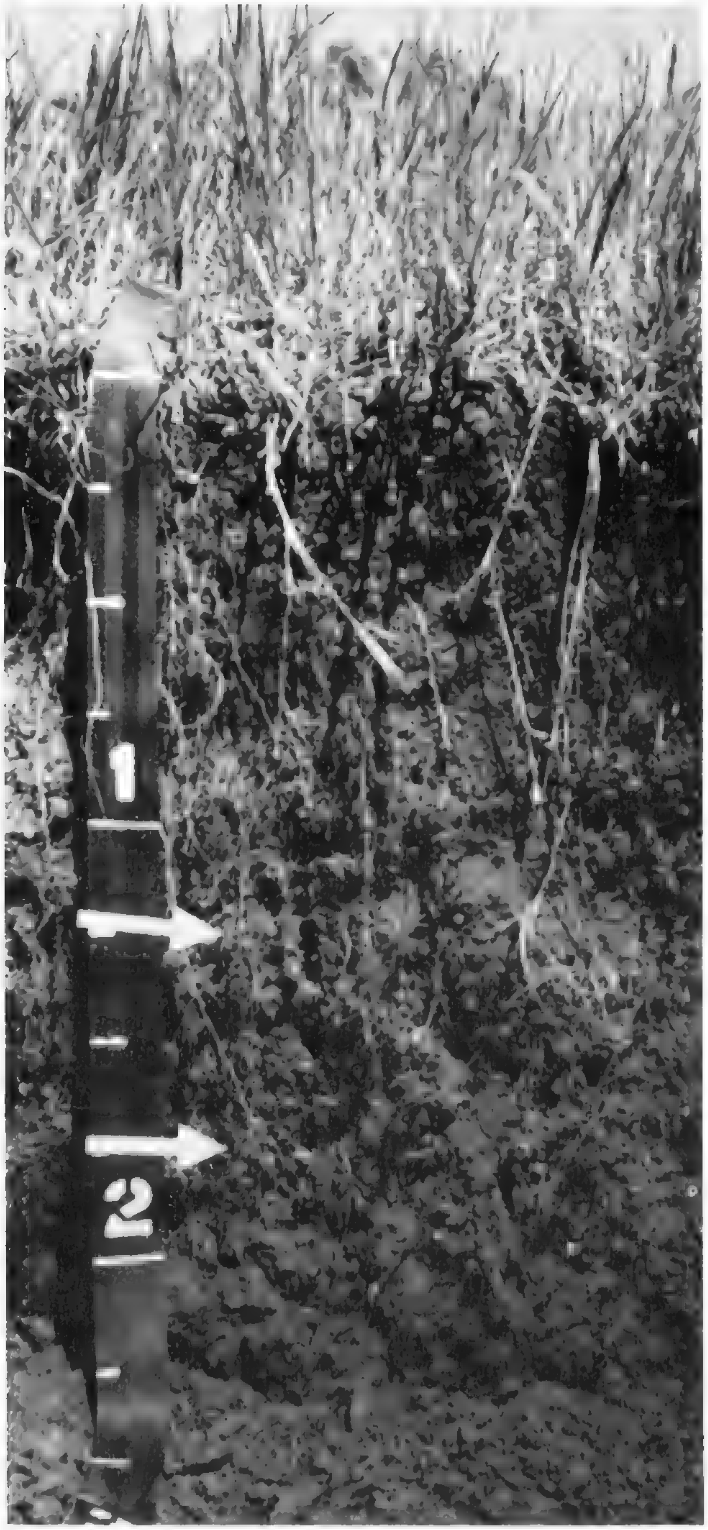

Figure 8.—Profile of Burchard clay loam, in an area of Burchard-Shelby clay loams, 7 to 12 percent slopes.

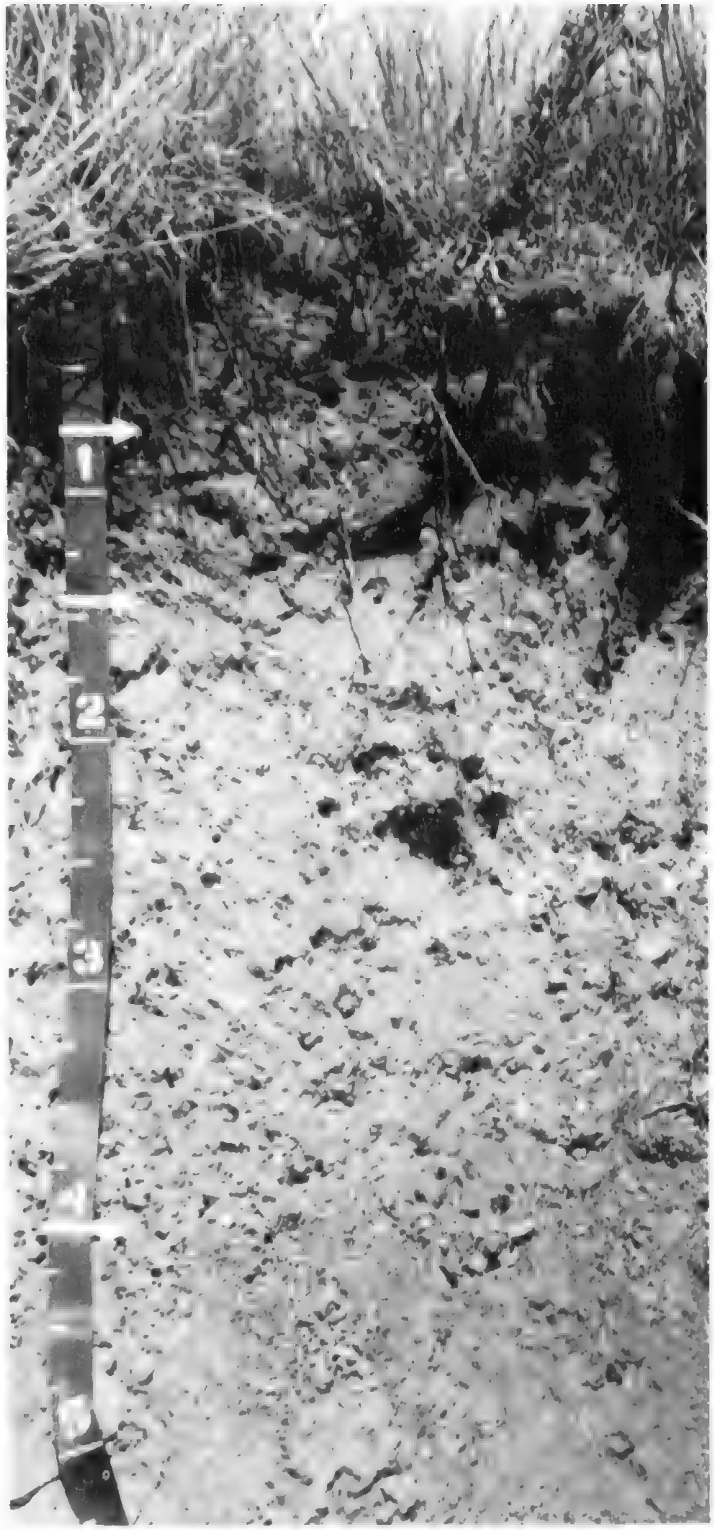

Figure 9.—Profile of Pawnee clay loam, 3 to 7 percent slopes.

Figure 10.—Profile of Shelby clay loam, in an area of Burchard-Shelby clay loams, 7 to 12 percent slopes.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION DATA

[Recorded in the period 1941-70 at Holton]

Month	Temperature					Precipitation				
	Average daily maximum	Average daily minimum	Average daily	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	In	In	In		In
January-----	37.9	16.2	27.1	66	-11	0.94	0.31	1.48	3	4.4
February----	44.3	21.8	33.1	70	- 5	0.89	0.26	1.24	2	3.6
March-------	52.5	28.1	40.3	83	0	2.10	0.73	3.68	3	4.4
April-------	67.8	41.2	54.6	90	21	3.18	1.48	4.56	6	0.2
May---------	77.1	52.9	65.0	93	31	4.35	2.72	5.88	7	0
June--------	84.5	62.1	73.3	100	45	6.52	3.30	8.87	8	0
July--------	89.9	66.1	77.9	104	50	3.97	1.80	5.49	6	0
August------	88.5	64.0	76.3	104	48	4.07	1.55	6.47	5	0
September---	80.5	55.5	67.9	99	35	4.05	1.63	6.47	7	0
October-----	70.5	44.8	57.7	92	23	2.64	0.62	4.00	4	0
November----	54.5	30.9	42.7	78	6	1.25	0.29	2.00	2	1.0
December----	42.3	21.4	31.8	67	- 7	1.32	0.58	2.10	3	5.6
Year------	65.7	42.1	53.9	104	-11	35.28	27.70	41.98	57	20.9

TABLE 2.--FREEZE DATES IN SPRING AND FALL

[Recorded in the period 1931-60 at Holton]

Probability	Minimum temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	April 12	April 22	May 8
2 years in 10 later than--	April 7	April 17	May 3
5 years in 10 later than--	March 29	April 7	April 23
First freezing temperature in fall:			
1 year in 10 earlier than--	October 22	October 10	October 3
2 years in 10 earlier than--	October 26	October 15	October 7
5 years in 10 earlier than--	November 5	October 24	October 17

TABLE 3.--GROWING SEASON LENGTH

[Recorded in the period 1931-60 at Holton]

Probability	Daily minimum temperature during growing season		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	195	177	158
8 years in 10	202	185	165
5 years in 10	214	198	179
2 years in 10	227	213	192
1 year in 10	233	220	199

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
Ba	Burchard-Shelby clay loams, 7 to 12 percent slopes	17,840	4.2
Bb	Burchard-Shelby clay loams, 7 to 12 percent slopes, eroded	17,440	4.1
Bc	Burchard-Shelby clay loams, 12 to 25 percent slopes	3,190	0.8
Ca	Chase silty clay loam	9,500	2.3
Cb	Clime-Sogn complex, 5 to 20 percent slopes	17,480	4.2
Ka	Kennebec silt loam	20,430	4.9
Kb	Kennebec soils	14,780	3.5
Kc	Kennebec soils, channeled	4,110	1.0
Ma	Martin silty clay loam, 3 to 8 percent slopes	40,670	9.7
Mb	Martin silty clay loam, 3 to 8 percent slopes, eroded	22,710	5.4
Mc	Martin-Vinland silty clay loams, 5 to 10 percent slopes	29,220	7.0
Oa	Olmitz clay loam, 2 to 5 percent slopes	2,900	0.7
Pa	Pawnee clay loam, 1 to 3 percent slopes	9,010	2.1
Pb	Pawnee clay loam, 3 to 7 percent slopes	83,330	19.8
Pc	Pawnee clay loam, 3 to 7 percent slopes, eroded	44,730	10.6
Pt	Pits, quarries	260	0.1
Ra	Reading silt loam	2,820	0.7
Sa	Shelby clay loam, 4 to 8 percent slopes	6,300	1.5
Sb	Shelby clay loam, 4 to 8 percent slopes, eroded	3,420	0.8
Va	Vinland silty clay loam, 6 to 14 percent slopes	2,980	0.7
Vb	Vinland-Rock outcrop complex, 20 to 40 percent slopes	1,800	0.4
Vc	Vinland-Sogn complex, 5 to 20 percent slopes	9,110	2.2
Wa	Wabash silty clay	12,930	3.1
Wb	Wymore silty clay loam, 1 to 3 percent slopes	18,670	4.4
Wc	Wymore silty clay loam, 2 to 5 percent slopes, eroded	13,730	3.3
Za	Zook silty clay loam	8,740	2.1
	Water	1,612	0.4
	Total	419,712	100.0

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE

[All yields were estimated for a high level of management in 1975. Absence of a yield figure indicates the crop is seldom grown or is not suited. Only arable soils are listed]

Soil name and map symbol	Corn	Soybeans	Grain sorghum	Wheat, winter	Alfalfa hay	Smooth bromegrass
	Bu	Bu	Bu	Bu	Ton	AUM[1]
Burchard-Shelby:						
[2]Ba	70	26	75	33	3.0	5.6
[2]Bb	60	22	70	30	2.5	4.8
Chase:						
Ca	85	36	95	45	4.5	8.0
Kennebec:						
Ka, [2]Kb	100	38	100	45	4.5	8.0
Martin:						
Ma	75	32	85	35	3.5	6.0
Mb	65	28	75	30	3.0	5.2
Martin-Vinland:						
[2]Mc	60	26	70	30	2.5	4.8
Olmitz:						
Oa	95	36	95	48	4.0	7.2
Pawnee:						
Pa	65	30	75	35	3.5	6.4
Pb	60	28	70	33	3.0	6.0
Pc	50	25	60	30	2.4	5.6
Reading:						
Ra	90	40	95	50	5.0	8.0
Shelby:						
Sa	85	32	90	40	3.8	6.0
Sb	80	28	85	38	3.3	5.6
Vinland:						
Va	---	---	---	---	---	3.2
Wabash:						
Wa	60	32	70	30	2.5	4.8
Wymore:						
Wb	70	30	75	35	3.5	6.4
Wc	60	28	70	33	3.0	5.6
Zook:						
Za	75	34	85	38	3.5	6.0

[1]Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for a period of 30 days.

[2]This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior of the whole map unit.

TABLE 6.--RANGE PRODUCTIVITY AND COMPOSITION

[Soils not listed are not in range sites; such soils can be used for grazing if grass cover is established]

Soil name and map symbol	Range site name	Potential production: Kind of year	Potential production: Dry weight	Common plant name	Composition
			Lb/acre		Pct
Burchard-Shelby:					
[1]Ba, [1]Bb, [1]Bc	Loamy Upland	Favorable	6,000	Big bluestem	30
		Normal	5,000	Little bluestem	15
		Unfavorable	4,000	Indiangrass	10
				Switchgrass	10
				Tall dropseed	5
				Side-oats grama	5
				Maximilian sunflower	5
				Leadplant	5
Chase:					
Ca	Loamy Lowland	Favorable	10,000	Big bluestem	40
		Normal	8,000	Indiangrass	10
		Unfavorable	6,000	Switchgrass	10
				Eastern gamagrass	10
				Prairie cordgrass	5
Clime:					
[1]Cb:					
Clime part	Limy Upland	Favorable	5,000	Little bluestem	30
		Normal	3,500	Big bluestem	20
		Unfavorable	2,500	Side-oats grama	15
				Indiangrass	5
				Switchgrass	5
				Blue grama	5
				Jersey tea	5
				Leadplant	5
Sogn part	Shallow Limy	Favorable	3,500	Side-oats grama	25
		Normal	2,500	Little bluestem	15
		Unfavorable	1,500	Blue grama	15
				Big bluestem	10
				Buffalograss	5
				Gray sagewort	5
				Smooth sumac	5
Kennebec:					
Ka, [1]Kb, [1]Kc	Loamy Lowland	Favorable	10,000	Big bluestem	40
		Normal	8,000	Indiangrass	10
		Unfavorable	6,000	Switchgrass	10
				Eastern gamagrass	10
				Prairie cordgrass	5
Martin:					
Ma, Mb	Loamy Upland	Favorable	6,000	Big bluestem	30
		Normal	5,000	Little bluestem	15
		Unfavorable	4,000	Indiangrass	10
				Switchgrass	10
				Tall dropseed	5
				Side-oats grama	5
				Maximilian sunflower	5
				Leadplant	5
[1]Mc:					
Martin part	Loamy Upland	Favorable	6,000	Big bluestem	30
		Normal	5,000	Little bluestem	15
		Unfavorable	4,000	Indiangrass	10
				Switchgrass	10
				Tall dropseed	5
				Side-oats grama	5
				Maximilian sunflower	5
				Leadplant	5

See footnote at end of table.

TABLE 6.--RANGE PRODUCTIVITY AND COMPOSITION--Continued

Soil name and map symbol	Range site name	Potential production		Common plant name	Composition
		Kind of year	Dry weight		
			Lb/acre		Pct
Martin:					
Vinland part	Loamy Upland	Favorable	5,500	Big bluestem	25
		Normal	4,500	Little bluestem	25
		Unfavorable	3,500	Indiangrass	10
				Switchgrass	10
				Leadplant	5
				Eastern gamagrass	5
				Compassplant	5
Olmitz:					
Oa	Loamy Upland	Favorable	---	Big bluestem	30
		Normal	---	Little bluestem	15
		Unfavorable	---	Indiangrass	10
				Switchgrass	10
				Tall dropseed	5
				Side-oats grama	5
				Maximilian sunflower	5
				Leadplant	5
Pawnee:					
Pa, Pb, Pc	Loamy Upland	Favorable	6,000	Big bluestem	30
		Normal	5,000	Little bluestem	23
		Unfavorable	4,000	Switchgrass	8
				Side-oats grama	7
				Tall dropseed	6
Reading:					
Ra	Loamy Lowland	Favorable	10,000	Big bluestem	40
		Normal	8,000	Indiangrass	10
		Unfavorable	6,000	Switchgrass	10
				Eastern gamagrass	10
				Prairie cordgrass	5
Shelby:					
Sa, Sb	Loamy Upland	Favorable	6,000	Big bluestem	30
		Normal	5,000	Little bluestem	15
		Unfavorable	4,000	Indiangrass	10
				Switchgrass	10
				Tall dropseed	5
				Side-oats grama	5
				Maximilian sunflower	5
				Leadplant	5
Vinland:					
Va	Loamy Upland	Favorable	5,500	Big bluestem	25
		Normal	4,500	Little bluestem	25
		Unfavorable	3,500	Indiangrass	10
				Switchgrass	10
				Leadplant	5
				Eastern gamagrass	5
				Compassplant	5
[1]Vb:					
Vinland part	Loamy Upland	Favorable	5,500	Big bluestem	25
		Normal	4,500	Little bluestem	25
		Unfavorable	3,500	Indiangrass	10
				Switchgrass	10
				Leadplant	5
				Eastern gamagrass	5
				Compassplant	5
Rock outcrop part.					

See footnote at end of table.

TABLE 6.--RANGE PRODUCTIVITY AND COMPOSITION--Continued

Soil name and map symbol	Range site name	Potential production: Kind of year	Potential production: Dry weight	Common plant name	Composition
			Lb/acre		Pct
Vinland:					
[1]Vc:					
Vinland part	Loamy Upland	Favorable	5,500	Big bluestem	25
		Normal	4,500	Little bluestem	25
		Unfavorable	3,500	Indiangrass	10
				Switchgrass	10
				Leadplant	5
				Eastern gamagrass	5
				Compassplant	5
Sogn part	Shallow Limy	Favorable	3,500	Side-oats grama	25
		Normal	2,500	Little bluestem	15
		Unfavorable	1,500	Blue grama	15
				Big bluestem	10
				Buffalograss	5
				Gray sagewort	5
				Smooth sumac	5
Wabash:					
Wa	Clay Lowland	Favorable	8,500	Switchgrass	15
		Normal	7,500	Indiangrass	15
		Unfavorable	6,000	Big bluestem	15
				Eastern gamagrass	15
				Little bluestem	10
				Prairie cordgrass	20
				Sunflower	5
				Eastern cottonwood	5
Wymore:					
Wb, Wc	Clay Upland	Favorable	6,000	Big bluestem	30
		Normal	5,000	Little bluestem	15
		Unfavorable	4,000	Indiangrass	10
				Switchgrass	10
				Tall dropseed	5
				Side-oats grama	5
				Maxmilian sunflower	5
				Leadplant	5
Zook:					
Za	Clay Lowland	Favorable	8,500	Big bluestem	30
		Normal	7,500	Indiangrass	15
		Unfavorable	6,000	Switchgrass	10
				Prairie cordgrass	10
				Little bluestem	5
				Eastern gamagrass	5
				Sedge	5

[1]This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior of the whole map unit.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY

[Only the soils suitable for production of commercial trees are listed in this table. Absence of an entry in a column means the information was not available]

Soil name and map symbol	Management concerns: Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Plant competition	Potential productivity: Important trees	Site index	Trees to plant
Chase:								
Ca	Slight	Moderate	Moderate	Slight	Slight	Bur oak	62	Pecan,
						Hackberry	69	green ash,
						Green ash	60	eastern cottonwood.
						Eastern cottonwood	66	
Kennebec:								
Ka, [1]Kb, [1]Kc	Slight	Slight	Slight	Slight	Moderate	Black walnut	75	Black walnut,
						Bur oak	63	bur oak,
						Hackberry	---	hackberry,
						Green ash	---	green ash,
						Eastern cottonwood	---	eastern cottonwood,
								American sycamore.
Reading:								
Ra	Slight	Slight	Slight	Slight	Moderate	Black walnut	73	Black walnut,
						Hackberry	69	green ash,
						Bur oak	60	hackberry,
						Shagbark hickory	62	American sycamore,
						Southern red oak	---	eastern cottonwood.
Wabash:								
Wa	Slight	Moderate	Severe	Moderate	Severe	Pin oak	75	Pin oak,
								pecan,
								eastern cottonwood.
Zook:								
Za	Slight	Severe	Moderate	Moderate	Severe	Pin oak	74	Eastern cottonwood,
						Eastern cottonwood	80	American sycamore,
						Green ash	---	silver maple.
						Hackberry	---	

[1]This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior of the whole map unit.

TABLE 8.--BUILDING SITE DEVELOPMENT

["Depth to rock" and some of the other terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry means soil was not rated]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Burchard:					
[1]Ba, [1]Bb:					
Burchard part--	Moderate: too clayey, slope.	Moderate: slope, shrink-swell, low strength.	Moderate: shrink-swell, slope, low strength.	Severe: slope.	Severe: low strength.
Shelby part-----	Moderate: slope, too clayey.	Moderate: slope, shrink-swell, low strength.	Moderate: slope, shrink-swell, low strength.	Severe: slope.	Severe: low strength.
[1]Bc:					
Burchard part--	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.
Shelby part-----	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.
Chase:					
Ca----------------	Severe: too clayey, wetness, floods.	Severe: floods, shrink-swell.	Severe: floods, shrink-swell.	Severe: floods, shrink-swell.	Severe: shrink-swell, low strength, floods.
Clime:					
[1]Cb:					
Clime part------	Severe: too clayey.	Moderate: shrink-swell, low strength, slope.	Moderate: depth to rock, slope, shrink-swell.	Severe: slope.	Severe: low strength.
Sogn part-------	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.
Kennebec:					
Ka, [1]Kb, [1]Kc------	Severe: floods, wetness.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods, frost action, low strength.
Martin:					
Ma, Mb------------	Severe: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: low strength, shrink-swell, frost action.
[1]Mc:					
Martin part-----	Severe: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: low strength, shrink-swell, frost action.
Vinland part----	Moderate: depth to rock.	Moderate: depth to rock.	Moderate: depth to rock.	Moderate: depth to rock, slope.	Moderate: depth to rock.

See footnote at end of table.

TABLE 8.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Olmitz:					
Oa	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
Pawnee:					
Pa, Pb, Pc	Severe: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength, frost action.
Pits, quarries: Pt.					
Reading:					
Ra	Moderate: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: low strength, frost action.
Shelby:					
Sa, Sb	Moderate: too clayey.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength, slope.	Severe: low strength.
Vinland:					
Va	Moderate: depth to rock, slope.	Moderate: depth to rock, slope.	Moderate: depth to rock, slope.	Severe: slope.	Moderate: depth to rock, slope.
[1]Vb:					
Vinland part	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Rock outcrop part.					
[1]Vc:					
Vinland part	Moderate: depth to rock, slope.	Moderate: depth to rock, slope.	Moderate: depth to rock, slope.	Severe: slope.	Moderate: depth to rock, slope.
Sogn part	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.
Wabash:					
Wa	Severe: wetness, floods, too clayey.	Severe: wetness, floods, shrink-swell.	Severe: wetness, floods, shrink-swell.	Severe: wetness, floods, shrink-swell.	Severe: wetness, floods, shrink-swell.
Wymore:					
Wb, Wc	Severe: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, frost action, low strength.
Zook:					
Za	Severe: wetness, floods, too clayey.	Severe: floods, low strength, shrink-swell.	Severe: floods, low strength, shrink-swell.	Severe: floods, low strength, shrink-swell.	Severe: floods, low strength, shrink-swell.

[1]This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior of the whole map unit.

TABLE 9.--CONSTRUCTION MATERIALS

["Shrink-swell" and some of the other terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," "poor," and "unsuited." Absence of an entry means soil was not rated]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Burchard:				
[1]Ba, [1]Bb:				
Burchard part	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey, slope.
Shelby part	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey, slope.
[1]Bc:				
Burchard part	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey, slope.
Shelby part	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: slope.
Chase:				
Ca	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer, too clayey.
Clime:				
[1]Cb:				
Clime part	Poor: low strength, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: too clayey.
Sogn part	Poor: thin layer.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: area reclaim.
Kennebec:				
Ka, [1]Kb, [1]Kc	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
Martin:				
Ma, Mb	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
[1]Mc:				
Martin part	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
Vinland part	Poor: thin layer.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey, area reclaim.
Olmitz:				
Oa	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
Pawnee:				
Pa, Pb, Pc	Poor: shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey, thin layer.

See footnote at end of table.

TABLE 9.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Pits, quarries. Pt.				
Reading: Ra	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
Shelby: Sa, Sb	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
Vinland: Va	Poor: thin layer.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey, slope, area reclaim.
[1]Vb: Vinland part	Poor: thin layer, slope.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: slope.
Rock outcrop part.				
[1]Vc: Vinland part	Poor: thin layer.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey, slope, area reclaim.
Sogn part	Poor: thin layer.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: area reclaim.
Wabash: Wa	Poor: wetness, shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness.
Wymore: Wb, Wc	Poor: shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: thin layer.
Zook: Za	Poor: wetness, shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey, wetness.

[1]This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior of the whole map unit.

TABLE 10.--SANITARY FACILITIES

["Depth to rock" and some of the other terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms used to rate soils. Absence of an entry means soil was not rated]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Burchard:					
[1]Ba, [1]Bb:					
Burchard part	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Moderate: slope.	Fair: too clayey, slope.
Shelby part	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Moderate: slope.	Fair: too clayey, slope.
[1]Bc:					
Burchard part	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Severe: slope.	Poor: slope.
Shelby part	Severe: percs slowly, slope.	Severe: slope.	Moderate: too clayey, slope.	Severe: slope.	Poor: slope.
Chase:					
Ca	Severe: floods, percs slowly, wetness.	Slight	Severe: floods, too clayey, wetness.	Severe: floods.	Poor: too clayey.
Clime:					
[1]Cb:					
Clime part	Severe: percs slowly, depth to rock.	Severe: depth to rock, slope.	Severe: too clayey, depth to rock.	Moderate: slope.	Poor: too clayey.
Sogn part	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Moderate: slope.	Poor: thin layer.
Kennebec:					
Ka, [1]Kb, [1]Kc	Severe: floods, wetness.	Severe: floods.	Severe: floods, wetness.	Severe: floods, wetness.	Good.
Martin:					
Ma, Mb	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: thin layer.
[1]Mc:					
Martin part	Severe: percs slowly.	Severe: slope.	Severe: too clayey.	Slight	Poor: thin layer.
Vinland part	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Slight	Poor: thin layer.
Olmitz:					
Oa	Moderate: percs slowly.	Moderate: slope, seepage.	Moderate: too clayey.	Slight	Fair: too clayey.
Pawnee:					
Pa, Pb, Pc	Severe: percs slowly	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey.

See footnote at end of table.

TABLE 10.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Pits, quarries:					
Pt.					
Reading:					
Ra	Moderate: percs slowly, floods.	Moderate: seepage.	Moderate: floods, too clayey.	Moderate: floods.	Fair: too clayey.
Shelby:					
Sa, Sb	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Vinland:					
Va	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Moderate: slope.	Poor: thin layer.
[1]Vb:					
Vinland part	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: slope.	Poor: thin layer, slope.
Rock outcrop part.					
[1]Vc:					
Vinland part	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Moderate: slope.	Poor: thin layer.
Sogn part	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Moderate: slope.	Poor: thin layer.
Wabash:					
Wa	Severe: percs slowly, floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness, too clayey.	Severe: floods, wetness.	Poor: wetness, too clayey.
Wymore:					
Wb, Wc	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Poor: too clayey.
Zook:					
Za	Severe: percs slowly, wetness, floods.	Severe: wetness, floods.	Severe: wetness, too clayey, floods.	Severe: wetness, floods.	Poor: too clayey.

[1]This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior of the whole map unit.

TABLE 11.--WATER MANAGEMENT

["Seepage," and some of the other terms that describe restrictive soil features are defined in the Glossary. Absence of an entry means soil was not evaluated]

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Burchard:						
[1]Ba, [1]Bb, [1]Bc:						
Burchard part	Slope	Low strength, shrink-swell.	Not needed	Complex slope, slow intake, erodes easily.	Slope, erodes easily.	Slope, erodes easily.
Shelby part	Slope	Low strength, shrink-swell.	Not needed	Slow intake, slope, erodes easily.	Erodes easily, slope.	Erodes easily, slope.
Chase:						
Ca	Favorable	Shrink-swell, low strength.	Floods, percs slowly.	Slow intake, floods.	Not needed	Percs slowly.
Clime:						
[1]Cb:						
Clime part	Depth to rock	Thin layer, low strength.	Not needed	Erodes easily, droughty, slope.	Depth to rock, erodes easily.	Depth to rock, erodes easily.
Sogn part	Depth to rock	Thin layer	Not needed	Rooting depth	Depth to rock	Rooting depth.
Kennebec:						
Ka, [1]Kb, [1]Kc	Seepage	Low strength, compressible, excess humus.	Floods, frost action.	Floods	Favorable	Favorable.
Martin:						
Ma, Mb	Favorable	Shrink-swell, low strength.	Not needed	Slow intake, slope.	Percs slowly	Favorable.
[1]Mc:						
Martin part	Favorable	Shrink-swell, low strength.	Not needed	Slow intake, slope.	Percs slowly	Favorable.
Vinland part	Depth to rock	Thin layer	Not needed	Rooting depth, slope.	Depth to rock	Rooting depth.
Olmitz:						
Oa	Favorable	Favorable	Not needed	Favorable	Erodes easily	Erodes easily.
Pawnee:						
Pa, Pb, Pc	Favorable	Shrink-swell	Not needed	Percs slowly, slow intake.	Percs slowly, erodes easily.	Percs slowly.
Pits, quarries:						
Pt.						
Reading:						
Ra	Favorable	Shrink-swell, erodes easily.	Not needed	Slow intake	Favorable	Favorable.
Shelby:						
Sa, Sb	Slope	Low strength, shrink-swell.	Not needed	Slow intake, slope, erodes easily.	Favorable	Erodes easily, slope.
Vinland:						
Va	Depth to rock	Thin layer	Not needed	Rooting depth, slope.	Depth to rock	Rooting depth.
[1]Vb:						
Vinland part	Depth to rock	Thin layer	Not needed	Rooting depth, slope.	Depth to rock	Rooting depth.

See footnote at end of table.

TABLE 11.--WATER MANAGEMENT--Continued

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Rock outcrop part.						
[1]Vc:						
Vinland part---	Depth to rock	Thin layer------	Not needed------	Rooting depth, slope.	Depth to rock	Rooting depth.
Sogn part-------	Depth to rock	Thin layer------	Not needed------	Rooting depth	Depth to rock	Rooting depth.
Wabash:						
Wa----------------	Favorable------	Shrink-swell, compressible, low strength.	Floods, percs slowly, wetness.	Slow intake, wetness, floods.	Percs slowly, wetness.	Percs slowly, wetness.
Wymore:						
Wb, Wc------------	Favorable------	Shrink-swell, low strength.	Not needed------	Slow intake, erodes easily.	Percs slowly, erodes easily.	Percs slowly, erodes easily.
Zook:						
Za----------------	Favorable------	Shrink-swell, low strength, hard to pack.	Floods, wetness, percs slowly.	Floods, wetness, percs slowly.	Not needed------	Wetness.

[1]This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior of the whole map unit.

TABLE 12.--RECREATIONAL DEVELOPMENT

["Percs slowly" and some of the other terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry means soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Burchard:				
[1]Ba, [1]Bb:				
Burchard part	Moderate: slope, percs slowly, too clayey.	Moderate: slope, too clayey.	Severe: slope.	Moderate: too clayey.
Shelby part	Moderate: percs slowly, too clayey, slope.	Moderate: too clayey, slope.	Severe: slope.	Moderate: too clayey.
[1]Bc:				
Burchard part	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: too clayey.
Shelby part	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: too clayey, slope.
Chase:				
Ca	Severe: floods.	Moderate: too clayey, wetness.	Moderate: too clayey, wetness, floods.	Moderate: too clayey.
Clime:				
[1]Cb:				
Clime part	Severe: too clayey.	Severe: too clayey.	Severe: too clayey, slope.	Severe: too clayey.
Sogn part	Moderate: too clayey, slope.	Moderate: too clayey, slope.	Severe: depth to rock, slope.	Moderate: too clayey.
Kennebec:				
Ka, [1]Kb	Severe: floods.	Slight	Moderate: floods, too clayey.	Slight.
[1]Kc	Severe: floods.	Moderate: floods.	Moderate: floods, too clayey.	Moderate: floods.
Martin:				
Ma, Mb	Moderate: too clayey, percs slowly.	Moderate: too clayey.	Moderate: too clayey, percs slowly, slope.	Moderate: too clayey.
[1]Mc:				
Martin part	Moderate: too clayey, percs slowly.	Moderate: too clayey.	Severe: slope.	Moderate: too clayey.
Vinland part	Moderate: too clayey.	Moderate: too clayey.	Severe: depth to rock, slope.	Moderate: too clayey.

See footnote at end of table.

TABLE 12.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Olmitz:				
Oa	Moderate: too clayey.	Moderate: too clayey.	Moderate: too clayey, slope.	Moderate: too clayey.
Pawnee:				
Pa, Pb, Pc	Moderate: percs slowly, too clayey.	Moderate: too clayey.	Moderate: percs slowly.	Moderate: too clayey.
Pits, quarries: Pt.				
Reading:				
Ra	Severe: floods.	Slight	Slight	Slight.
Shelby:				
Sa, Sb	Moderate: percs slowly, too clayey.	Moderate: too clayey.	Severe: slope.	Moderate: too clayey.
Vinland:				
Va	Moderate: too clayey, slope.	Moderate: too clayey, slope.	Severe: depth to rock, slope.	Moderate: too clayey.
[1]Vb:				
Vinland part	Severe: slope.	Severe: slope.	Severe: depth to rock, slope.	Severe: slope.
Rock outcrop part.				
[1]Vc:				
Vinland part	Moderate: too clayey, slope.	Moderate: too clayey, slope.	Severe: depth to rock, slope.	Moderate: too clayey.
Sogn part	Moderate: too clayey, slope.	Moderate: too clayey, slope.	Severe: depth to rock, slope.	Moderate: too clayey.
Wabash:				
Wa	Severe: floods, wetness, percs slowly.	Severe: wetness, too clayey.	Severe: wetness, too clayey.	Severe: wetness, too clayey.
Wymore:				
Wb, Wc	Moderate: too clayey, percs slowly.	Moderate: too clayey.	Moderate: slope, too clayey, percs slowly.	Moderate: too clayey.
Zook:				
Za	Severe: wetness, floods.	Moderate: wetness, too clayey.	Severe: wetness.	Moderate: too clayey, wetness.

[1]This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior of the whole map unit.

TABLE 13.--WILDLIFE HABITAT POTENTIALS

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates the soil was not rated]

Soil name and map symbol	Potential for habitat elements								Potential as habitat for--			
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
Burchard:												
[1]Ba, [1]Bb:												
Burchard part	Fair	Good	Good	---	Good	Good	Very poor.	Very poor.	Good	---	Very poor.	Good.
Shelby part	Fair	Good	Fair	---	Good	Good	Poor	Poor	Fair	---	Poor	Good.
[1]Bc:												
Burchard part	Poor	Fair	Good	---	Fair	Good	Very poor.	Very poor.	Good	---	Very poor.	Good.
Shelby part	Poor	Fair	Fair	---	Fair	Good	Poor	Poor	Fair	---	Poor	Good.
Chase:												
Ca	Good	Good	Good	Good	Good	Good	Good	Fair	Good	Good	Fair	---
Clime:												
[1]Cb:												
Clime part	Fair	Fair	Fair	---	---	Fair	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
Sogn part	Very poor.	Very poor.	Poor	---	---	Poor	Very poor.	Very poor.	Very poor.	---	Very poor.	Poor.
Kennebec:												
Ka, [1]Kb, [1]Kc	Good	Good	Good	Good	Good	---	Poor	Poor	Good	Good	Poor	---
Martin:												
Ma, Mb	Fair	Good	---	Good	Good	Good	Poor	Very poor.	Good	---	Very poor.	Good.
[1]Mc:												
Martin part	Fair	Good	---	Good	Good	Good	Poor	Very poor.	Good	---	Very poor.	Good.
Vinland part	Poor	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.	Fair.
Olmitz:												
Oa	Good	Good	Fair	Good	Good	Good	Poor	Poor	Good	Good	Poor	Good.
Pawnee:												
Pa, Pb, Pc	Fair	Good	Good	---	Fair	Fair	Very poor.	Good	Good	---	Poor	Fair.
Pits, quarries:												
Pt.												
Reading:												
Ra	Good	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor	---
Shelby:												
Sa, Sb	Fair	Good	Fair	---	Good	Good	Poor	Poor	Fair	Good	Poor	Good.
Vinland:												
Va	Poor	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.	Fair.
[1]Vb:												
Vinland part	Poor	Poor	Fair	Fair	Fair	---	Very poor.	Very poor.	Poor	Fair	Very poor.	---
Rock outcrop part.												

See footnote at end of table.

TABLE 13.--WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements								Potential as habitat for--			
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
Vinland:												
[1]Vc:												
Vinland part	Poor	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.	Fair.
Sogn part	Very poor.	Very poor.	Poor	---	---	Poor	Very poor.	Very poor.	Very poor.	---	Very poor.	Poor.
Wabash:												
Wa	Poor	Poor	Poor	Poor	Poor	---	Poor	Good	Poor	Poor	Fair	---
Wymore:												
Wb, Wc	Fair	Good	Fair	Good	Good	Fair	Very poor.	Very poor.	Fair	Good	Very poor.	Fair.
Zook:												
Za	Good	Fair	Good	Fair	Poor	---	Good	Good	Fair	Fair	Good	---

[1]This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior of the whole map unit.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS

[The symbol < means less than; > means greater than. Absence of an entry means data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
Burchard:											
[1]Ba:											
Burchard part---	0-14	Clay loam--------	CL	A-6, A-7	0-5	95-100	95-100	85-95	60-80	35-50	14-24
	14-31	Clay loam--------	CL	A-6, A-7	0-5	95-100	90-100	85-95	65-80	35-50	20-30
	31-60	Clay loam--------	CL	A-6, A-7	0-5	95-100	90-100	85-95	60-80	35-50	20-30
Shelby part-----	0-15	Clay loam--------	CL	A-6	0	90-100	85-98	75-90	55-70	30-40	11-20
	15-43	Clay loam--------	CL	A-6, A-7	0	90-100	85-98	75-90	55-70	35-45	15-25
	43-60	Clay loam--------	CL	A-6, A-7	0	90-100	85-98	75-90	55-70	35-45	15-25
[1]Bb:											
Burchard part---	0-5	Clay loam--------	CL	A-6, A-7	0-5	95-100	95-100	85-95	60-80	35-50	14-24
	5-24	Clay loam--------	CL	A-6, A-7	0-5	95-100	90-100	85-95	65-80	35-50	20-30
	24-60	Clay loam--------	CL	A-6, A-7	0-5	95-100	90-100	85-95	60-80	35-50	20-30
Shelby part-----	0-6	Clay loam--------	CL	A-6	0	90-100	85-98	75-90	55-70	30-40	11-20
	6-31	Clay loam--------	CL	A-6, A-7	0	90-100	85-98	75-90	55-70	35-45	15-25
	31-60	Clay loam--------	CL	A-6, A-7	0	90-100	85-98	75-90	55-70	35-45	15-25
[1]Bc:											
Burchard part---	0-14	Clay loam--------	CL	A-6, A-7	0-5	95-100	95-100	85-95	60-80	35-50	14-24
	14-31	Clay loam--------	CL	A-6, A-7	0-5	95-100	90-100	85-95	65-80	35-50	20-30
	31-60	Clay loam--------	CL	A-6, A-7	0-5	95-100	90-100	85-95	60-80	35-50	20-30
Shelby part-----	0-15	Clay loam--------	CL	A-6	0	90-100	85-98	75-90	55-70	30-40	11-20
	15-43	Clay loam--------	CL	A-6, A-7	0	90-100	85-98	75-90	55-70	35-45	15-25
	43-60	Clay loam--------	CL	A-6, A-7	0	90-100	85-98	75-90	55-70	35-45	15-25
Chase:											
Ca----------------	0-21	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	90-100	35-45	15-25
	21-60	Silty clay, silty clay loam, clay.	CH, CL	A-7-6	0	100	100	95-100	90-100	40-60	20-35
Clime:											
[1]Cb:											
Clime part------	0-9	Silty clay-------	CL, CH	A-7, A-6	0-20	90-100	90-100	85-100	80-95	38-60	18-30
	9-22	Silty clay, clay, silty clay loam.	CH, CL	A-7, A-6	0	100	100	95-100	85-95	38-60	18-35
	22-35	Silty clay, clay	CL, CH	A-7, A-6	0	85-100	80-100	75-95	60-90	30-55	11-30
	35	Unweathered bedrock.									
Sogn part-------	0-12	Silty clay loam	CL	A-6, A-7	0-10	85-100	85-100	85-100	80-95	25-45	11-23
	12	Unweathered bedrock.									
Kennebec:											
Ka, [1]Kb, [1]Kc-------	0-48	Silt loam--------	CL, ML	A-6, A-7	0	100	100	95-100	90-100	30-50	10-20
	48-60	Silt loam, silty clay loam.	CL, ML	A-6, A-7, A-4	0	100	100	95-100	90-100	30-50	5-20
Martin:											
Ma, Mb------------	0-17	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	80-99	35-50	15-25
	17-60	Silty clay, clay	CH, CL	A-7	0	100	100	95-100	80-98	41-70	25-40
[1]Mc:											
Martin part-----	0-17	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	80-99	35-50	15-25
	17-60	Silty clay, clay	CH, CL	A-7	0	100	100	95-100	80-98	41-70	25-40
Vinland part----	0-17	Silty clay loam	ML, CL	A-6, A-7	0	85-100	85-100	80-100	75-95	35-50	10-25
	17	Weathered bedrock.									

See footnote at end of table.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Olmitz:											
Oa----------------	0-32	Clay loam--------	CL	A-6	0	100	90-100	85-95	60-80	30-40	11-20
	32-60	Clay loam--------	CL	A-6, A-7	0	100	90-100	85-95	60-80	35-45	15-25
Pawnee:											
Pa, Pb, Pc---------	0-16	Clay loam--------	CL	A-6	0	95-100	95-100	85-100	70-90	30-40	10-20
	16-52	Clay-------------	CH	A-7	0	95-100	95-100	85-100	70-85	50-70	25-45
	52-60	Clay loam, sandy clay loam, clay.	CL, CH	A-7, A-6	0	95-100	95-100	80-100	70-90	35-55	20-40
Pits, quarries: Pt.											
Reading:											
Ra----------------	0-8	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	100	90-100	85-100	25-40	5-20
	8-60	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	90-100	35-50	15-30
Shelby:											
Sa, Sb------------	0-15	Clay loam--------	CL	A-6	0	90-100	85-98	75-90	55-70	30-40	11-20
	15-43	Clay loam--------	CL	A-6, A-7	0	90-100	85-98	75-90	55-70	35-45	15-25
	43-60	Clay loam--------	CL	A-6, A-7	0	90-100	85-98	75-90	55-70	35-45	15-25
Vinland:											
Va----------------	0-17	Silty clay loam	ML, CL	A-6, A-7	0	85-100	85-100	80-100	75-95	35-50	10-25
	17	Weathered bedrock.									
[1]Vb:											
Vinland part----	0-17	Silty clay loam	ML, CL	A-6, A-7	0	85-100	85-100	80-100	75-95	35-50	10-25
	17	Weathered bedrock.									
Rock outcrop part.											
[1]Vc:											
Vinland part----	0-17	Silty clay loam	ML, CL	A-6, A-7	0	85-100	85-100	80-100	75-95	35-50	10-25
	17	Weathered bedrock.									
Sogn part--------	0-12	Silty clay loam	CL	A-6, A-7	0-10	85-100	85-100	85-100	80-95	25-45	11-23
	12	Unweathered bedrock.									
Wabash:											
Wa----------------	0-24	Silty clay-------	CH	A-7	0	100	100	100	95-100	50-75	30-55
	24-60	Silty clay, clay	CH	A-7	0	100	100	100	95-100	52-78	30-55
Wymore:											
Wb, Wc------------	0-10	Silty clay loam	CL, CH	A-6, A-7	0	100	100	95-100	95-100	38-55	15-30
	10-32	Silty clay-------	CH	A-7	0	100	100	95-100	95-100	55-65	30-40
	32-60	Silty clay loam	CL, CH	A-6, A-7	0	100	100	95-100	85-100	35-55	20-35
Zook:											
Za----------------	0-18	Silty clay loam	MH, CH, CL, OL	A-7	0	100	100	95-100	95-100	45-70	20-40
	18-60	Silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	95-100	60-85	40-60

[1]This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior of the whole map unit.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS

[The symbol < means less than; > means greater then. The erosion tolerance factor (T) is for the entire profile. Absence of an entry means data were not available or were not estimated]

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Risk of corrosion		Erosion factors		Wind erodibility group
						Uncoated steel	Concrete	K	T	
	In	In/hr	In/in	pH						
Burchard:										
[1]Ba:										
Burchard part---	0-14	0.6-2.0	0.17-0.19	5.6-7.3	Moderate	Moderate	Low-------	0.32	5	6
	14-31	0.2-0.6	0.15-0.17	6.6-7.8	Moderate	Moderate	Low-------	0.32		
	31-60	0.2-0.6	0.14-0.14	7.4-8.4	Moderate	Moderate	Low-------	0.32		
Shelby part------	0-15	0.6-2.0	0.20-0.22	5.6-6.5	Moderate	Moderate	Moderate	0.28	5	6
	15-43	0.2-0.6	0.16-0.18	5.6-7.3	Moderate	Moderate	Moderate	0.28		
	43-60	0.2-0.6	0.16-0.18	6.6-8.4	Moderate	Moderate	Moderate	0.37		
[1]Bb:										
Burchard part---	0-5	0.6-2.0	0.17-0.19	5.6-7.3	Moderate	Moderate	Low-------	0.32	5	6
	5-24	0.2-0.6	0.15-0.17	6.6-7.8	Moderate	Moderate	Low-------	0.32		
	24-60	0.2-0.6	0.14-0.14	7.4-8.4	Moderate	Moderate	Low-------	0.32		
Shelby part------	0-6	0.6-2.0	0.20-0.22	5.6-6.5	Moderate	Moderate	Moderate	0.28	5	6
	6-31	0.2-0.6	0.16-0.18	5.6-7.8	Moderate	Moderate	Moderate	0.28		
	31-60	0.2-0.6	0.16-0.18	6.6-8.4	Moderate	Moderate	Moderate	0.37		
[1]Bc:										
Burchard part---	0-14	0.6-2.0	0.17-0.19	5.6-7.3	Moderate	Moderate	Low-------	0.32	5	6
	14-31	0.2-0.6	0.15-0.17	6.6-7.8	Moderate	Moderate	Low-------	0.32		
	31-60	0.2-0.6	0.14-0.14	7.4-8.4	Moderate	Moderate	Low-------	0.32		
Shelby part------	0-15	0.6-2.0	0.20-0.22	5.6-6.5	Moderate	Moderate	Moderate	0.28	5	6
	15-43	0.2-0.6	0.16-0.18	5.6-7.8	Moderate	Moderate	Moderate	0.28		
	43-60	0.2-0.6	0.16-0.18	6.6-8.4	Moderate	Moderate	Moderate	0.37		
Chase:										
Ca-----------------	0-10	0.2-0.6	0.21-0.24	5.6-7.3	Moderate	Moderate	Low-------	0.37	5	7
	10-60	0.06-0.2	0.11-0.19	5.6-7.8	High-------	High------	Low-------	0.37		
Clime:										
[1]Cb:										
Clime part-------	0-9	0.06-0.6	0.12-0.20	7.4-8.4	Moderate	High------	Low-------	0.28	3	4
	9-22	0.06-0.6	0.12-0.18	7.9-8.4	Moderate	High------	Low-------	0.28		
	22-35	0.06-0.6	0.11-0.15	7.9-8.4	Moderate	High------	Low-------	0.28		
	35	---	---	---	-----------	----------	----------	---		
Sogn part--------	0-12	0.6-2.0	0.17-0.22	6.1-8.4	Moderate	Low-------	Low-------	0.28	1	4L
	12	---	---	---	-----------	----------	----------	---		
Kennebec:										
Ka, [1]Kb, [1]Kc-------	0-48	0.6-2.0	0.22-0.24	5.6-6.5	Moderate	Moderate	Low-------	0.32	5	6
	48-60	0.6-2.0	0.20-0.22	6.1-7.3	Moderate	Moderate	Low-------	0.43		
Martin:										
Ma, Mb-------------	0-17	0.2-0.6	0.21-0.23	5.6-6.5	Moderate	High------	Low-------	0.37	4	7
	17-60	0.06-0.2	0.12-0.18	5.6-7.8	High-------	High------	Low-------	0.37		
[1]Mc:										
Martin part------	0-17	0.2-0.6	0.21-0.23	5.6-6.5	Moderate	High------	Low-------	0.37	4	7
	17-60	0.06-0.2	0.12-0.18	5.6-7.8	High-------	High------	Low-------	0.37		
Vinland part-----	0-17	0.6-2.0	0.21-0.24	5.6-7.8	Moderate	Moderate	Low-------	0.37	2	7
	17	---	---	---	-----------	----------	----------	---		
Olmitz:										
Oa-----------------	0-32	0.6-2.0	0.19-0.21	5.6-6.5	Moderate	Moderate	Moderate	0.28	5	6
	32-60	0.2-2.0	0.15-0.17	5.1-6.5	Moderate	Moderate	Moderate	0.28		
Pawnee:										
Pa, Pb, Pc----------	0-16	0.2-0.6	0.17-0.19	5.6-6.5	Moderate	Moderate	Low-------	0.37	3	6
	16-52	0.06-0.2	0.09-0.11	6.1-8.4	High-------	High------	Low-------	0.37		
	52-60	0.2-0.6	0.14-0.16	7.9-8.4	High-------	High------	Low-------	0.37		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete	Erosion factors: K	Erosion factors: T	Wind erodibility group
	In	In/hr	In/in	pH						
Pits, quarries: Pt.										
Reading:										
Ra	0-8	0.6-2.0	0.21-0.23	5.6-7.3	Low	Low	Low	0.32	5	6
	8-60	0.2-2.0	0.18-0.20	5.6-7.3	Moderate	Moderate	Low	0.43		
Shelby:										
Sa, Sb	0-15	0.6-2.0	0.20-0.22	5.6-6.5	Moderate	Moderate	Moderate	0.28	5	6
	15-43	0.2-0.6	0.16-0.18	5.6-7.8	Moderate	Moderate	Moderate	0.28		
	43-60	0.2-0.6	0.16-0.18	6.6-8.4	Moderate	Moderate	Moderate	0.37		
Vinland:										
Va	0-17	0.6-2.0	0.21-0.24	5.6-7.8	Moderate	Moderate	Low	0.37	2	7
	17	---	---	---	---	---	---	---		
[1]Vb:										
Vinland part	0-17	0.6-2.0	0.21-0.24	5.6-7.8	Moderate	Moderate	Low	0.37	2	7
	17	---	---	---	---	---	---	---		
Rock outcrop part.										
[1]Vc:										
Vinland part	0-17	0.6-2.0	0.21-0.24	5.6-7.8	Moderate	Moderate	Low	0.37	2	7
	17	---	---	---	---	---	---	---		
Sogn part	0-12	0.6-2.0	0.17-0.22	6.1-8.4	Moderate	Low	Low	0.28	1	4L
	12	---	---	---	---	---	---	---		
Wabash:										
Wa	0-24	<0.06	0.12-0.14	5.6-7.3	Very	High	Moderate	0.28	5	4
	24-60	<0.06	0.08-0.12	5.6-7.8	Very	High	Moderate	0.28		
Wymore:										
Wb, Wc	0-10	0.2-0.6	0.21-0.23	5.6-6.5	Moderate	High	Moderate	0.37	4	6
	10-32	0.06-0.2	0.11-0.14	5.6-6.5	High	High	Moderate	0.37		
	32-60	0.2-0.6	0.18-0.20	6.6-7.3	High	High	Low	0.37		
Zook:										
Za	0-18	0.2-0.6	0.21-0.23	5.6-7.8	High	High	Moderate	0.28	5	7
	18-60	0.06-0.2	0.11-0.13	5.6-7.8	High	High	Moderate	0.28		

[1]This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior of the whole map unit.

TABLE 16.--SOIL AND WATER FEATURES

[Absence of an entry indicates the feature is not a concern. See text for descriptions of symbols and "flooding" and "water table" in the Glossary for such terms as "rare," "brief," and "perched." The symbol < means less than; > means greater than]

Soil name and map symbol	Hydro-logic group	Flooding: Frequency	Flooding: Duration	Flooding: Months	High water table: Depth	High water table: Kind	High water table: Months	Bedrock: Depth	Bedrock: Hardness	Potential frost action
					Ft			In		
Burchard:										
[1]Ba, [1]Bb, [1]Bc:										
Burchard part	B	None	---	---	>6.0	---	---	>60	---	Moderate.
Shelby part	B	None	---	---	>6.0	---	---	>60	---	Moderate.
Chase:										
Ca	C	Rare to occasional.	Very brief	Mar-Sep	1.0-3.0	Perched	Feb-May	>60	---	Moderate.
Clime:										
[1]Cb:										
Clime part	C	None	---	---	>6.0	---	---	20-40	Rippable	Moderate.
Sogn part	D	None	---	---	>6.0	---	---	4-20	Hard	Moderate.
Kennebec:										
Ka, [1]Kb, [1]Kc	B	Common	Brief	Feb-Nov	2.0-5.0	Apparent	Nov-May	>60	---	High.
Martin:										
Ma, Mb	C	None	---	---	>6.0	---	---	>40	Rippable	High.
[1]Mc:										
Martin part	C	None	---	---	>6.0	---	---	>40	Rippable	High.
Vinland part	D	None	---	---	>6.0	---	---	10-20	Rippable	Moderate.
Olmitz:										
Oa	B	None to rare	---	---	>6.0	---	---	>60	---	Moderate.
Pawnee:										
Pa, Pb, Pc	D	None	---	---	>6.0	---	---	>60	---	High.
Pits, quarries:										
Pt.										
Reading:										
Ra	C	None to rare	---	---	>6.0	---	---	>60	---	High.
Shelby:										
Sa, Sb	B	None	---	---	>6.0	---	---	>60	---	Moderate.
Vinland:										
Va	D	None	---	---	>6.0	---	---	10-20	Rippable	Moderate.
[1]Vb:										
Vinland part	D	None	---	---	>6.0	---	---	10-20	Rippable	Moderate.
Rock outcrop part.										
[1]Vc:										
Vinland part	D	None	---	---	>6.0	---	---	10-20	Rippable	Moderate.
Sogn part	D	None	---	---	>6.0	---	---	4-20	Hard	Moderate.
Wabash:										
Wa	D	Common	Brief to long.	Nov-May	0-1.0	Perched	Nov-May	>60	---	Moderate.
Wymore:										
Wb, Wc	D	None	---	---	>6.0	---	---	>60	---	High.
Zook:										
Za	D	Common	Brief	Mar-Jun	1.0-3.0	Apparent	Nov-May	>60	---	High.

[1]This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior of the whole map unit.

TABLE 17.--ENGINEERING TEST DATA

[Tests performed by the State Highway Commission of Kansas, in accordance with procedures of the American Association of State Highway and Transportation Officials (AASHTO) except as stated in footnotes 1 and 2]

Soil name and location	Parent material	Report number	Depth	Moisture density[1/]: Maximum	Moisture density[1/]: Optimum	Percentage less than 3 inches passing sieve--[2/]: No. 10	No. 40	No. 200	Percentage smaller than--[2/]: 0.05 mm	0.02 mm	0.005 mm	0.002 mm	Liquid limit	Plasticity index	Classification[3/]: AASHTO	Unified
			In	lb/cu ft	Pct								Pct			
Burchard clay loam: 620 feet east and 30 feet south of the northwest corner of sec. 13, T. 6 S., R. 14 E.; 5 miles north and 3 miles west of Holton, Kans. (Modal)	Glacial till (Kansan).	S74-Kans-85-2-1	0-8	101	17	97	81	57	51	38	26	20	38	14	A-6(6)	CL
		85-2-3	14-26	105	18	100	90	68	62	51	37	29	44	20	A-7-6 (13)	CL
		85-2-5	31-60	114	13	100	91	72	68	57	40	31	38	19	A-6(12)	CL
Shelby clay loam: 1,700 feet east and 30 feet south of the northwest corner of sec. 21, T. 6 S., R. 15 E.; 4 miles north of Holton, Kans. (Modal)	Glacial till.	S74-Kans-85-1-1	0-9	108	15	100	89	51	48	37	25	19	29	5	A-4(1)	ML
		85-1-3	12-24	110	16	100	84	43	40	35	28	26	31	12	A-6(2)	SC
		85-1-5	34-48	116	13	99	74	34	31	26	20	17	28	13	A-2-6 (1)	SC
Vinland silty clay loam: 700 feet south and 160 feet east of the northwest corner of sec. 13, T. 5 S., R. 16 E.; 2 miles east and 2 miles north of Whiting, Kans. (Modal)	Residuum derived from sandy or silty shale.	S74-Kans-85-3-1	0-10	107	16	100	95	71	62	43	24	17	31	9	A-4(5)	CL
		85-3-2	10-16	110	15	100	99	68	56	36	21	15	28	8	A-4(4)	CL
		85-3-3	16-30	109	14	100	99	41	29	18	9	7	26	3	A-4(0)	SM

1/Based on AASHTO Designation T99-61, Method A (1), with the following variations: (1) all material is ovendried at 230° F; (2) all material is crushed in a laboratory crusher after drying; and (3) no time is allowed for dispersion of moisture after mixing with the soil material.

2/Mechanical analyses according to the AASHTO Designation T88-57 (1), with the following variations: (1) all material is ovendried at 230° F and crushed in a laboratory crusher; (2) the sample is not soaked prior to dispersion; (3) sodium silicate is used as the dispersing agent; and (4) dispersing time, in minutes, is established by dividing the plasticity index value by 2; the maximum time is 15 minutes and the minimum time 1 minute. Results by this procedure can differ somewhat from results obtained by the soil survey procedure of the Soil Conservation Service. In the AASHTO procedure, the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analyses used in this table are not suitable for naming textural classes for soils.

3/AASHTO classification based on AASHTO Designation M145-49 (1). Unified classification based on MIL-STD-619B (2). The SCS and Bureau of Public Roads have agreed to consider that all soils having plasticity indexes within two points of the A-line are to be given a borderline classification. An example of a borderline classification is CL-ML.

TABLE 18.--CLASSIFICATION OF THE SOILS

Soil name	Family or higher taxonomic class
Burchard	Fine-loamy, mixed, mesic Typic Argiudolls
Chase	Fine, montmorillonitic, mesic Aquic Argiudolls
Clime	Fine, mixed, mesic Udic Haplustolls
Kennebec	Fine-silty, mixed, mesic Cumulic Hapludolls
Martin	Fine, montmorillonitic, mesic Aquic Argiudolls
Olmitz	Fine-loamy, mixed, mesic Cumulic Hapludolls
Pawnee	Fine, montmorillonitic, mesic Aquic Argiudolls
Reading	Fine-silty, mixed, mesic Typic Argiudolls
Shelby	Fine-loamy, mixed, mesic Typic Argiudolls
Sogn	Loamy, mixed, mesic Lithic Haplustolls
Vinland	Loamy, mixed, mesic, shallow Typic Hapludolls
Wabash	Fine, montmorillonitic, mesic Vertic Haplaquolls
Wymore	Fine, montmorillonitic, mesic Aquic Argiudolls
Zook	Fine, montmorillonitic, mesic Cumulic Haplaquolls

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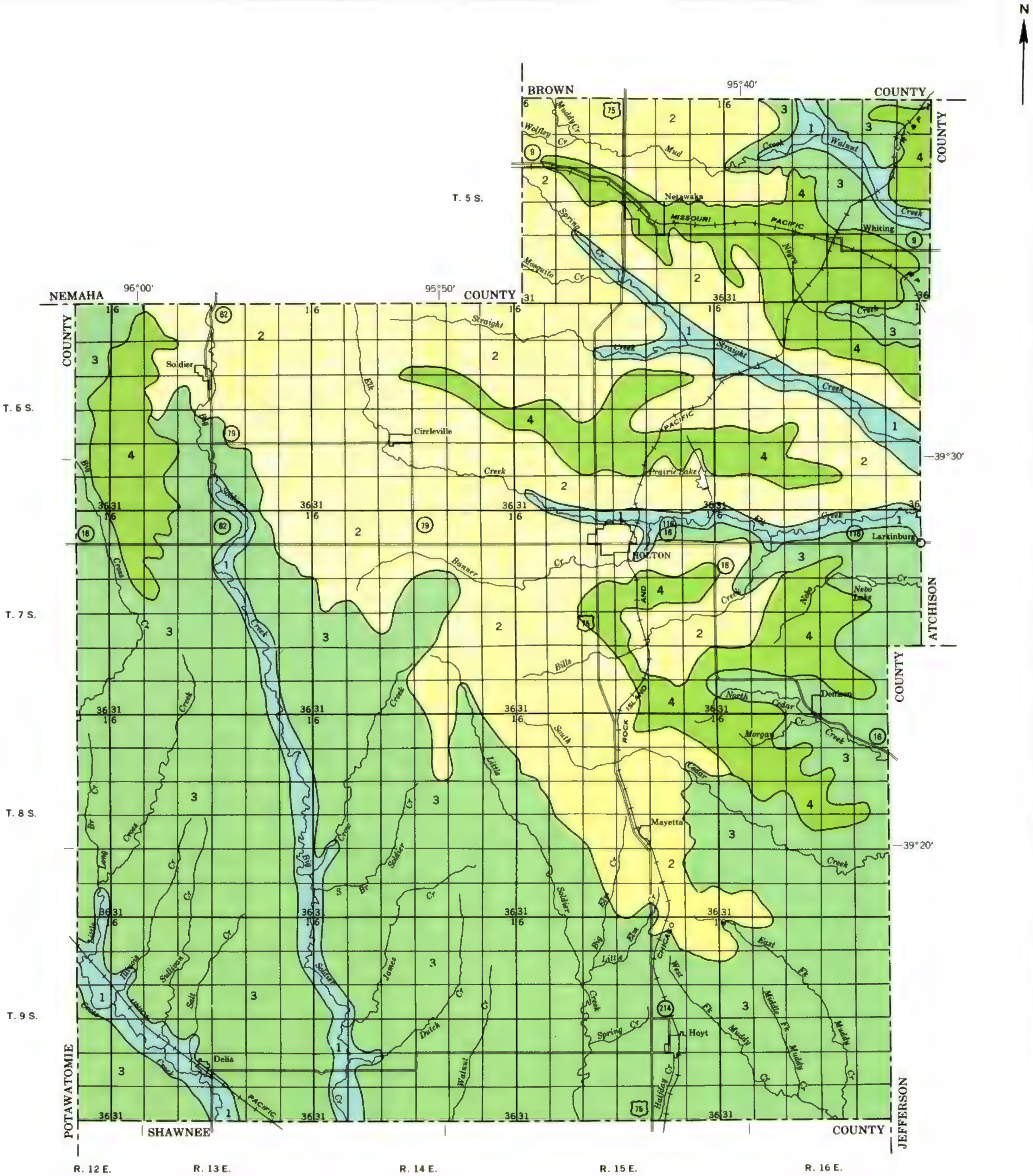


SOIL LEGEND

1	Kennebec–Zook–Wabash: Deep, nearly level, moderately well drained, poorly drained, and very poorly drained soils that have a silt loam or silty clay subsoil and formed in alluvium
2	Pawnee–Shelby–Burchard: Deep, gently sloping to steep, well drained and moderately well drained soils that have a clay or clay loam subsoil and formed in glacial material; on uplands
3	Martin–Pawnee–Sogn: Deep and shallow, moderately well drained to somewhat excessively drained, gently sloping to steep soils that dominantly have a silty clay or clay subsoil and formed in residuum derived from shale, limestone, or glacial material; on uplands
4	Pawnee–Wymore: Deep, moderately well drained and well drained, gently sloping and moderately sloping soils that have a clay, silty clay, or silty clay loam subsoil and formed in glacial material and loess; on uplands

Compiled 1978

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
KANSAS AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP

JACKSON COUNTY, KANSAS

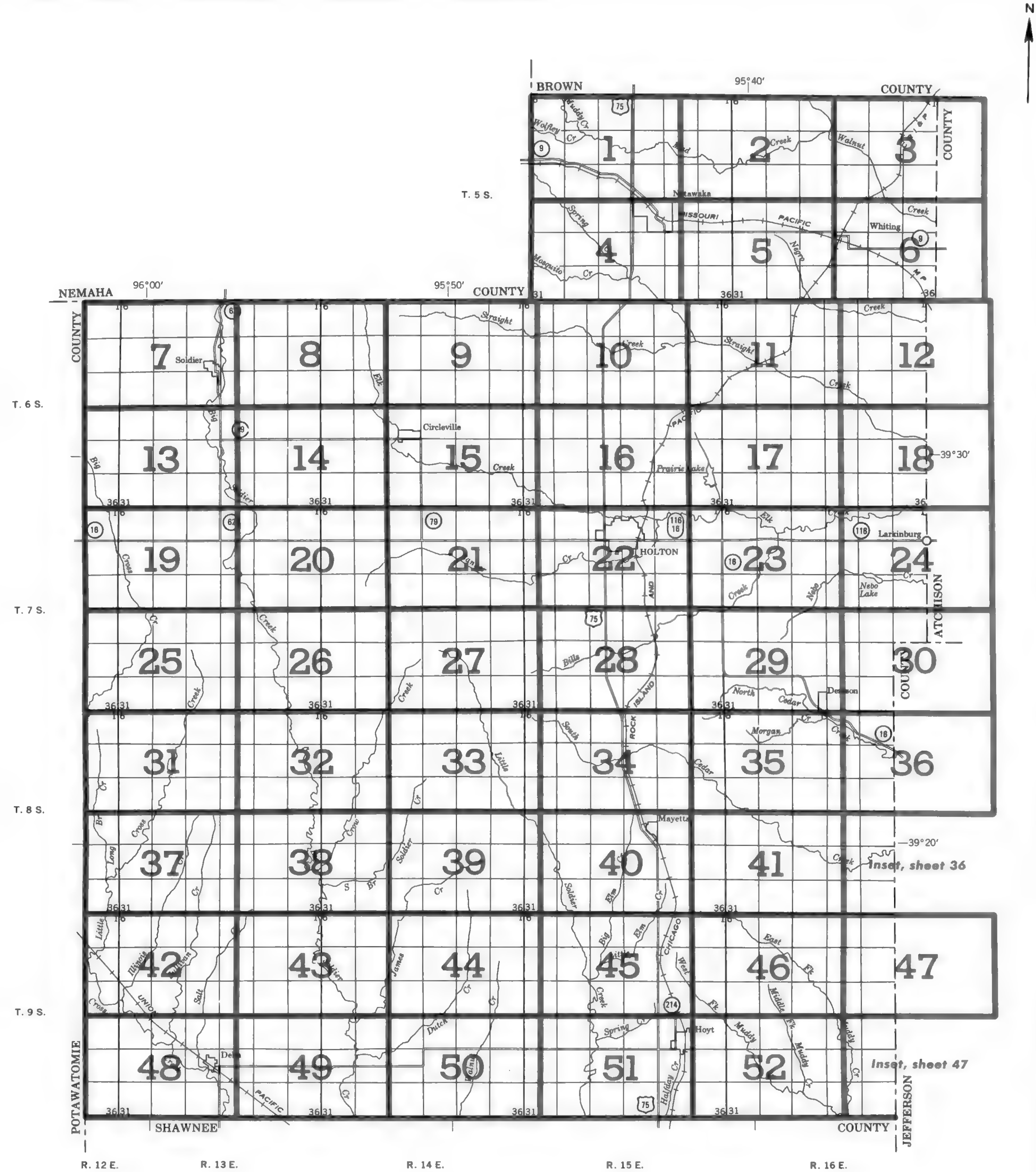
Scale 1:190,080

1 0 1 2 3 4 Miles

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.



INDEX TO MAP SHEETS

JACKSON COUNTY, KANSAS

Scale 1:190,080

1 0 1 2 3 4 Miles

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline & neatline

AD HOC BOUNDARY (label)

- Small airport, airfield, park, oilfield, cemetery, or flood pool — Davis Airstrip; FLOOD POOL LINE

STATE COORDINATE TICK

LAND DIVISION CORNERS (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEMS & DESIGNATIONS

- Interstate — 79
- Federal — 410
- State — 52
- County, farm or ranch — 378

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

- Without road
- With road
- With railroad

DAMS

- Large (to scale)
- Medium or small — water; w

PITS

- Gravel pit
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School
- Indian mound (label) — Indian Mound
- Located object (label) — Tower
- Tank (label) — GAS
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Canals or ditches
  - Double-line (label) — CANAL
  - Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial — water; w
- Intermittent — int; i

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS — CeA; FoB2

ESCARPMENTS

- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

GULLY

DEPRESSION OR SINK

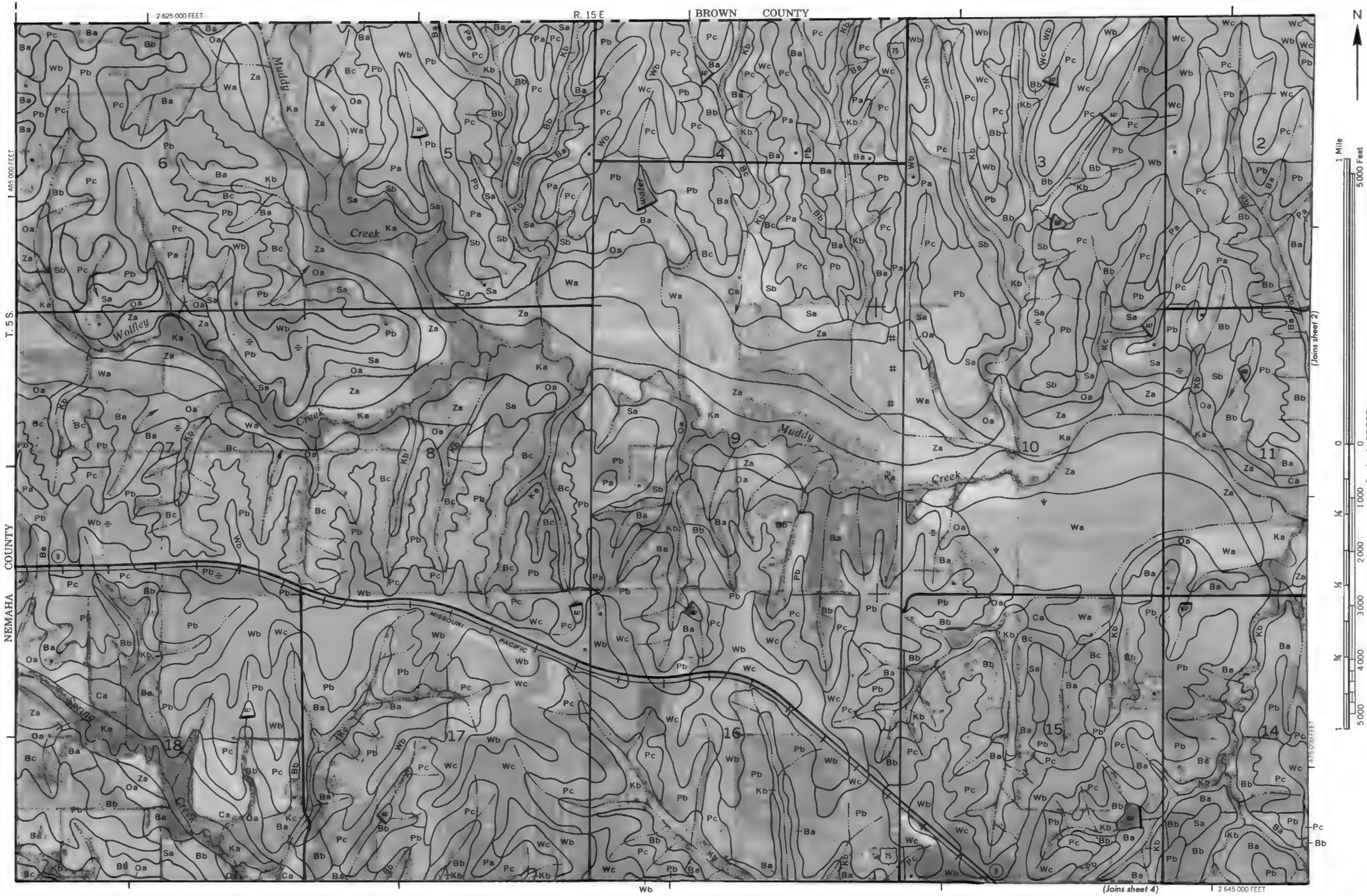
SOIL SAMPLE SITE (normally not shown) — S

MISCELLANEOUS

- Blowout
- Clay spot
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot
- Severely eroded spot
- Slide or slip (tips point upslope)
- Stony spot, very stony spot
- Borrow or fill area up to 5 acres in size

SOIL LEGEND

SYMBOL	NAME
Ba	Burchard–Shelby clay loams, 7 to 12 percent slopes
Bb	Burchard–Shelby clay loams, 7 to 12 percent slopes, eroded
Bc	Burchard–Shelby clay loams, 12 to 25 percent slopes
Ca	Chase silty clay loam
Cb	Clime–Sogn complex, 5 to 20 percent slopes
Ka	Kennebec silt loam
Kb	Kennebec soils
Kc	Kennebec soils, channeled
Ma	Martin silty clay loam, 3 to 8 percent slopes
Mb	Martin silty clay loam, 3 to 8 percent slopes, eroded
Mc	Martin–Vinland silty clay loams, 5 to 10 percent slopes
Oa	Olmitz clay loam, 2 to 5 percent slopes
Pa	Pawnee clay loam, 1 to 3 percent slopes
Pb	Pawnee clay loam, 3 to 7 percent slopes
Pc	Pawnee clay loam, 3 to 7 percent slopes, eroded
Pt	Pits, quarries
Ra	Reading silt loam
Sa	Shelby clay loam, 4 to 8 percent slopes
Sb	Shelby clay loam, 4 to 8 percent slopes, eroded
Va	Vinland silty clay loam, 6 to 14 percent slopes
Vb	Vinland–Rock outcrop complex, 20 to 40 percent slopes
Vc	Vinland–Sogn complex, 5 to 20 percent slopes
Wa	Wabash silty clay
Wb	Wymore silty clay loam, 1 to 3 percent slopes
Wc	Wymore silty clay loam, 2 to 5 percent slopes, eroded
Za	Zook silty clay loam



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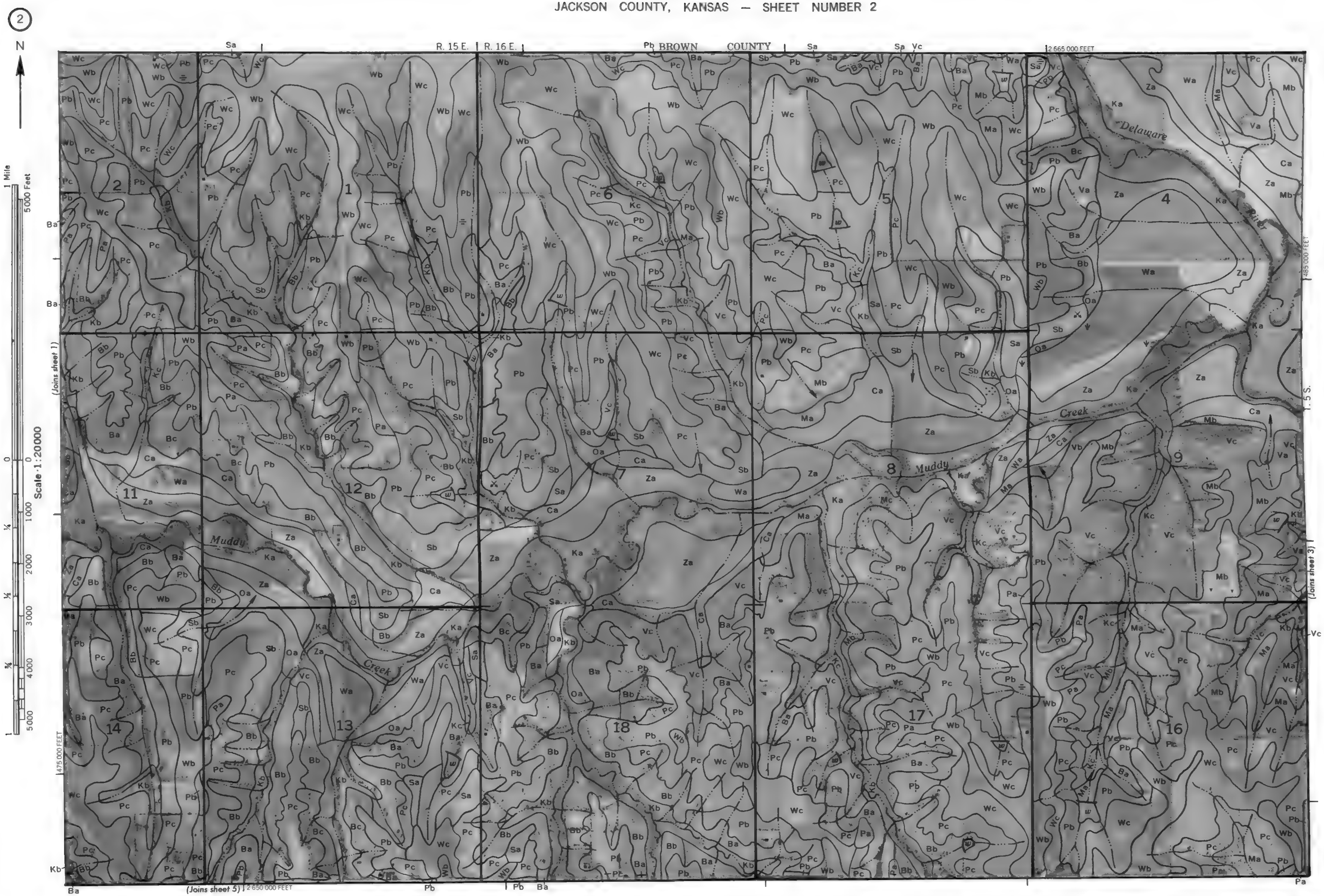

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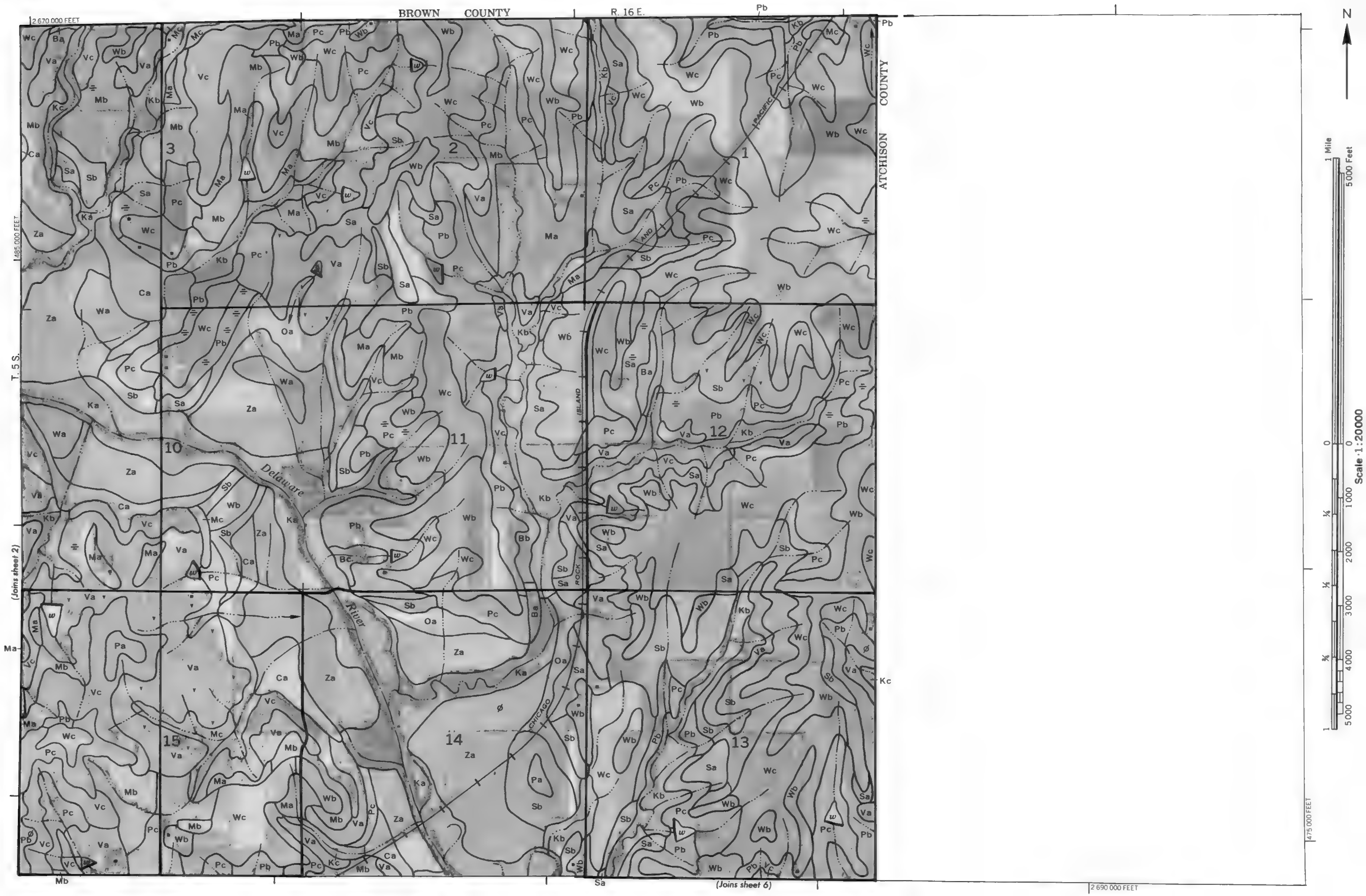

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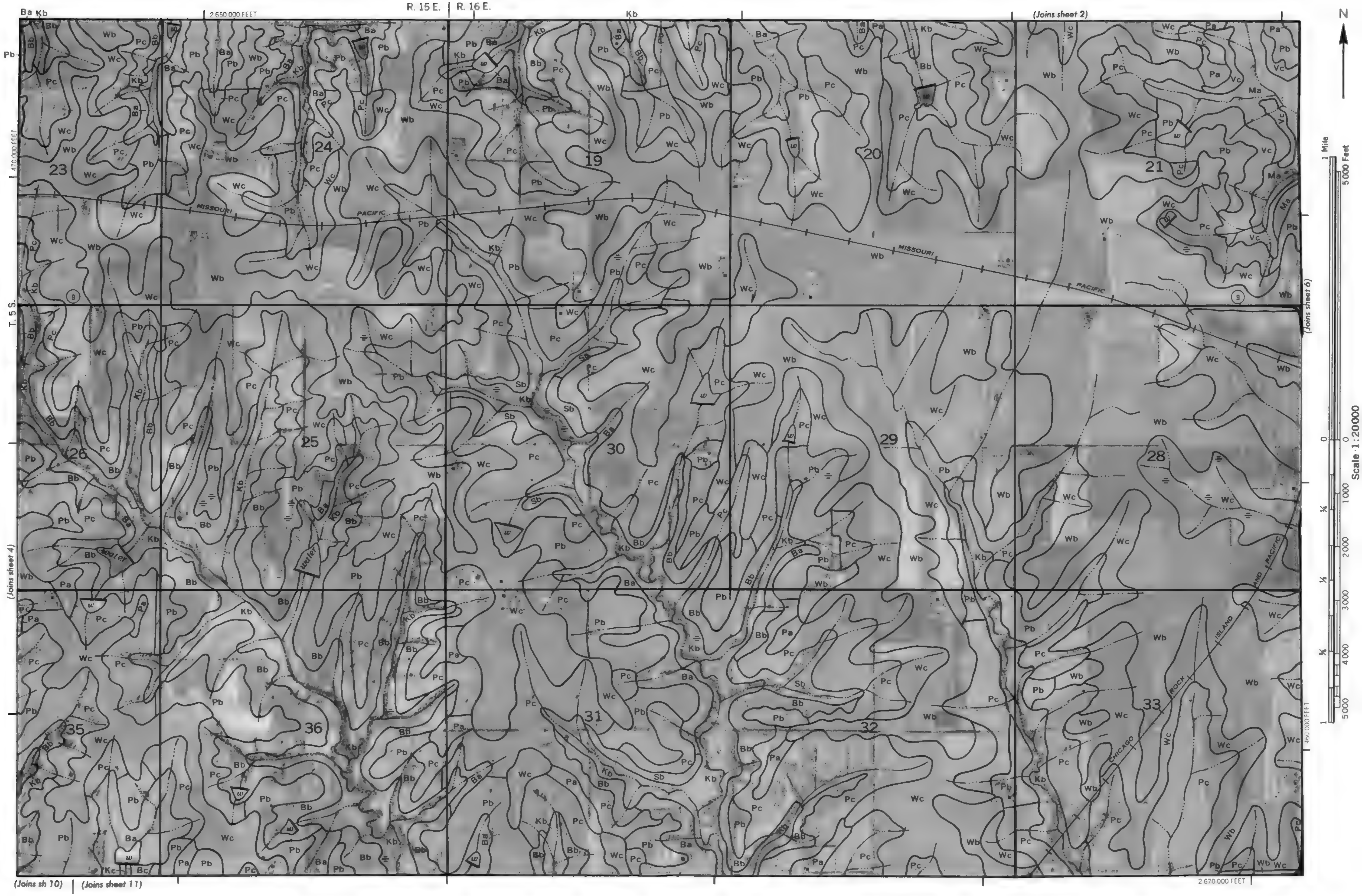

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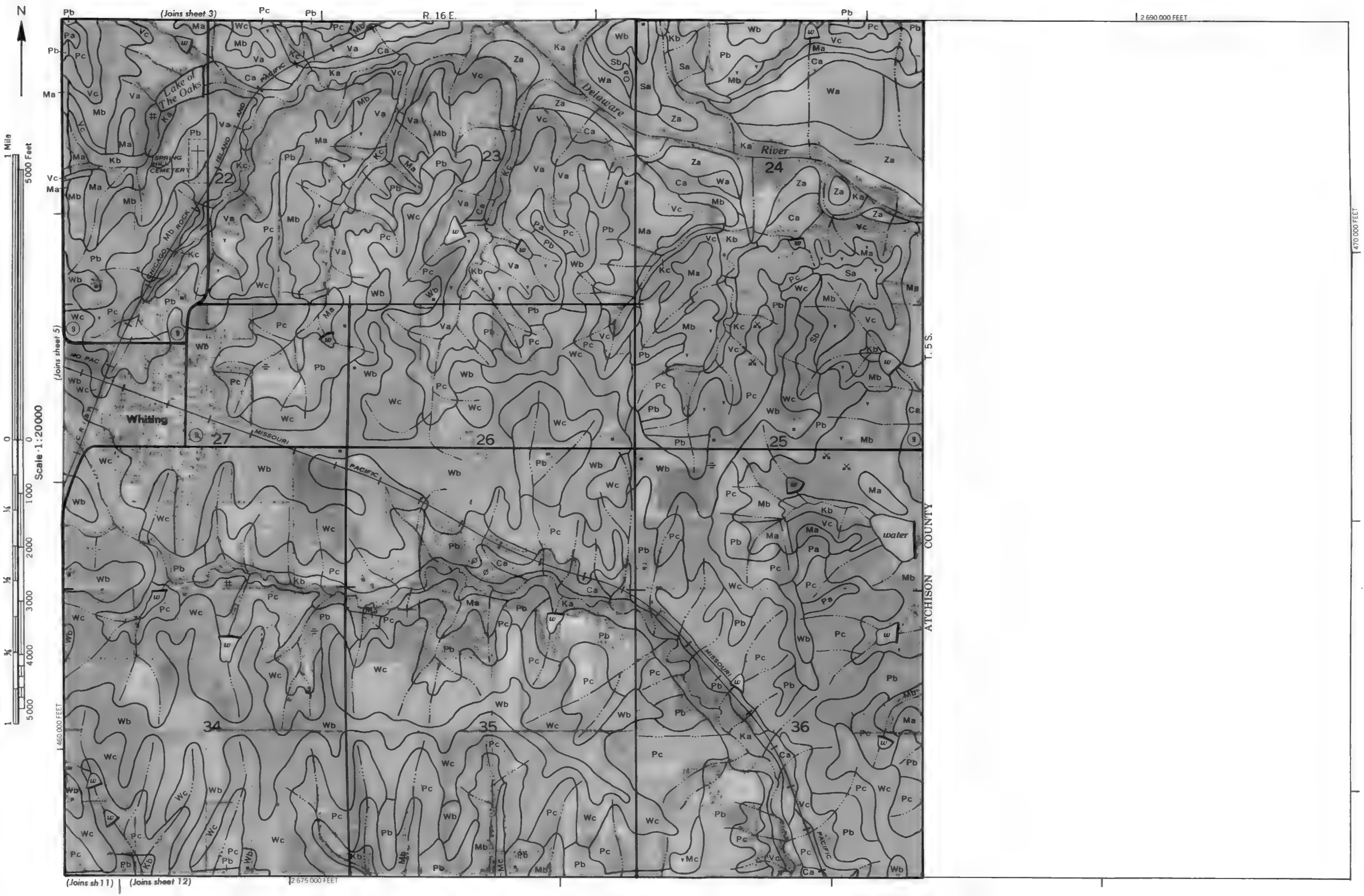

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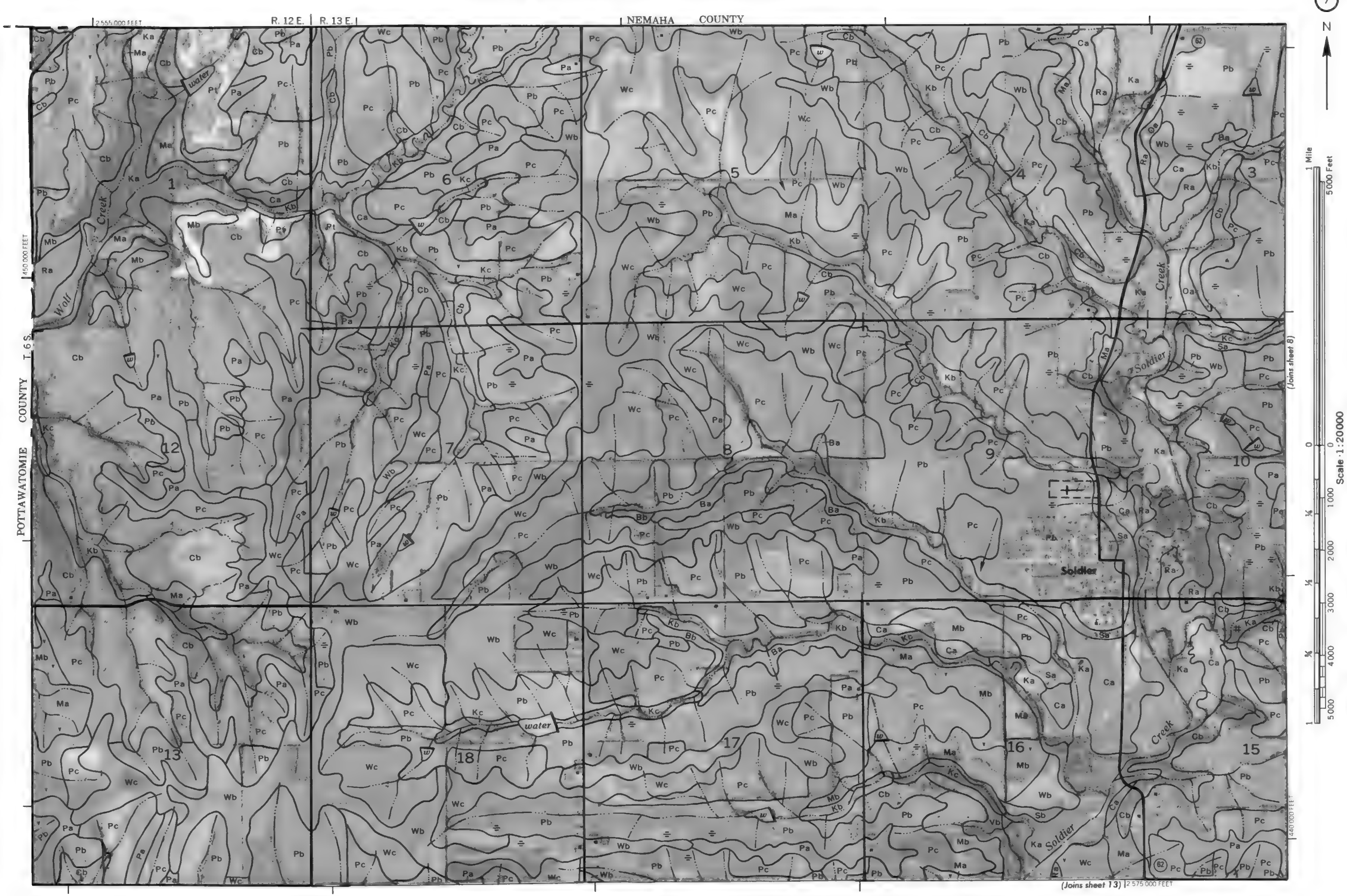

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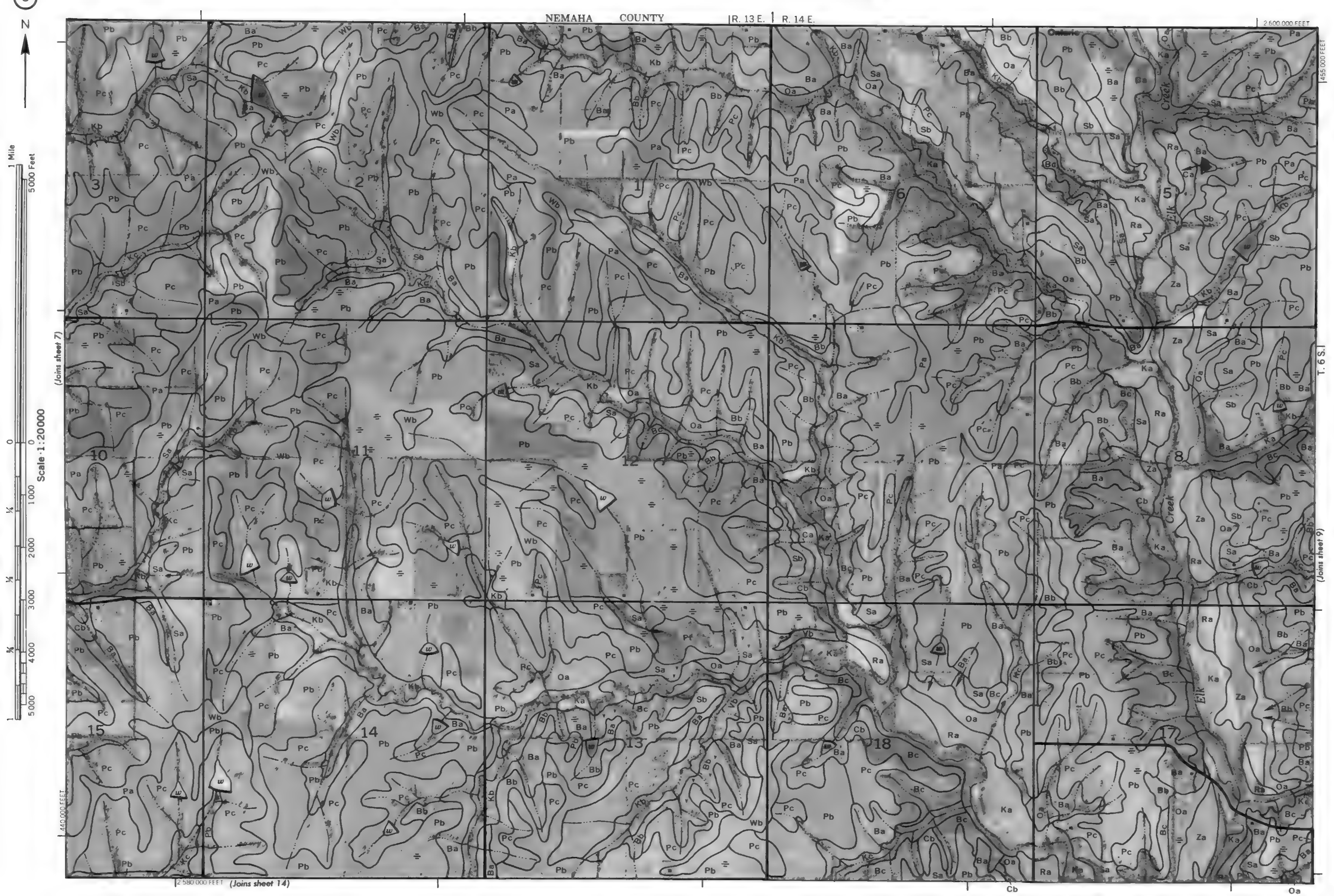
JACKSON COUNTY, KANSAS — SHEET NUMBER 8



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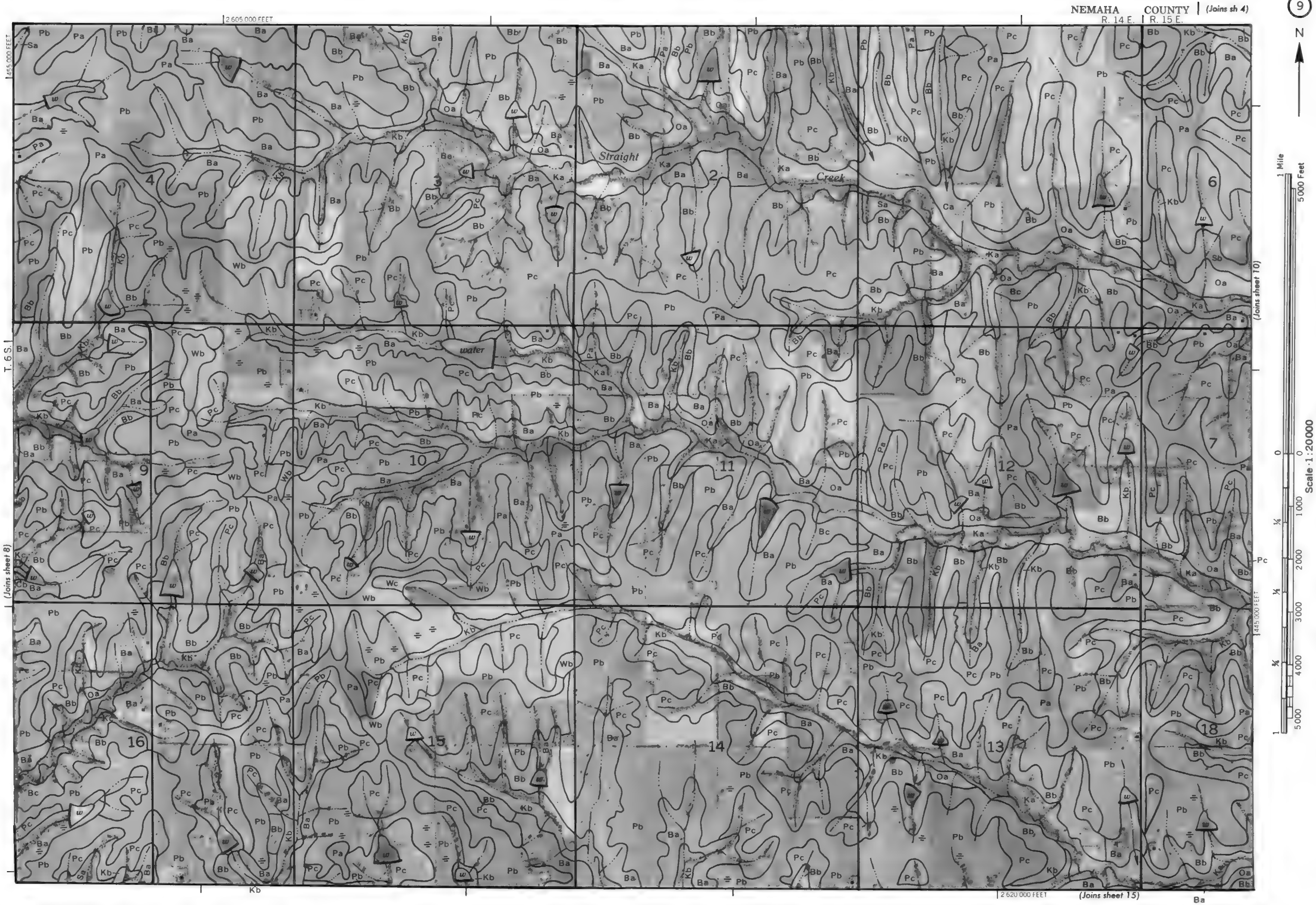

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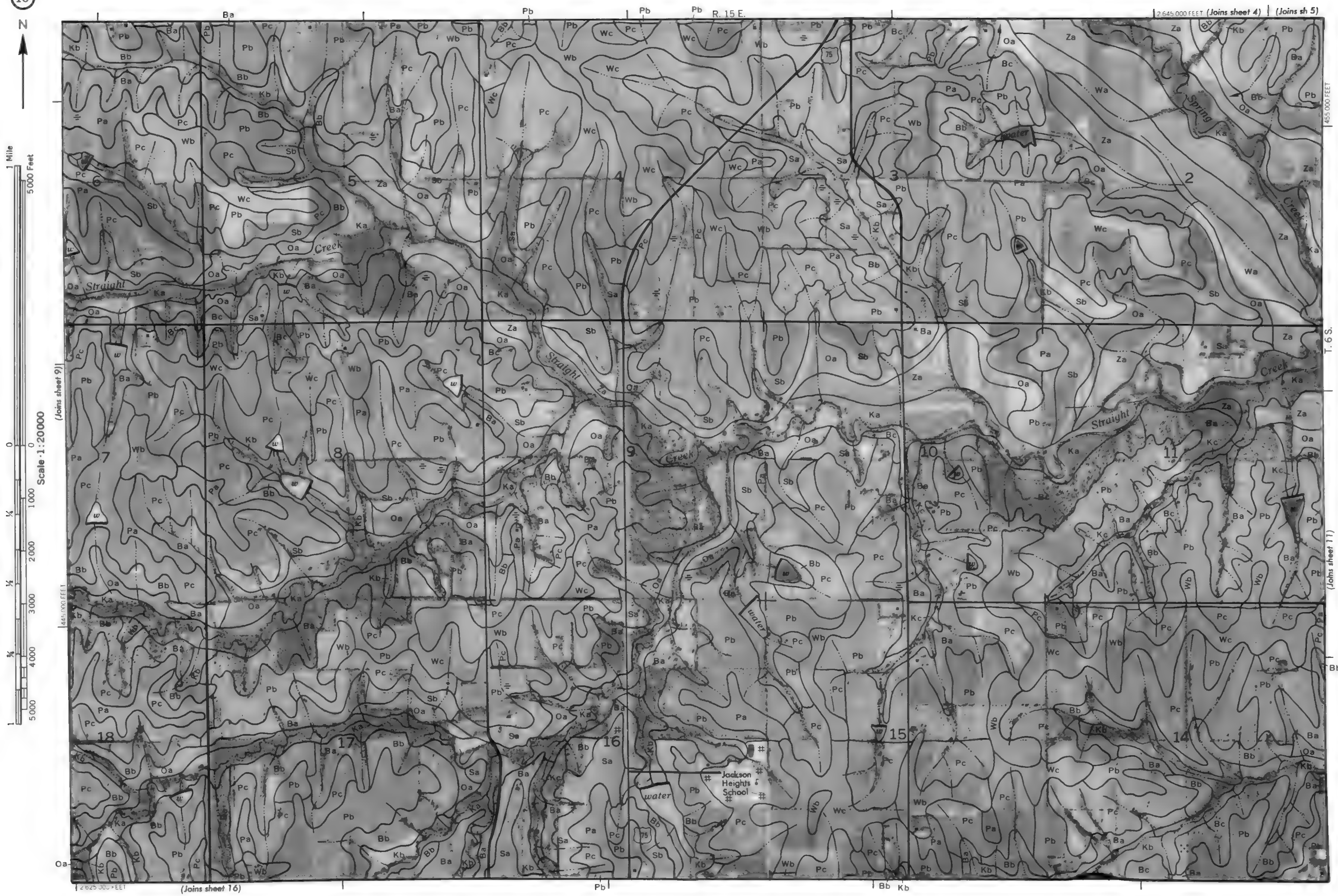
JACKSON COUNTY, KANSAS — SHEET NUMBER 10



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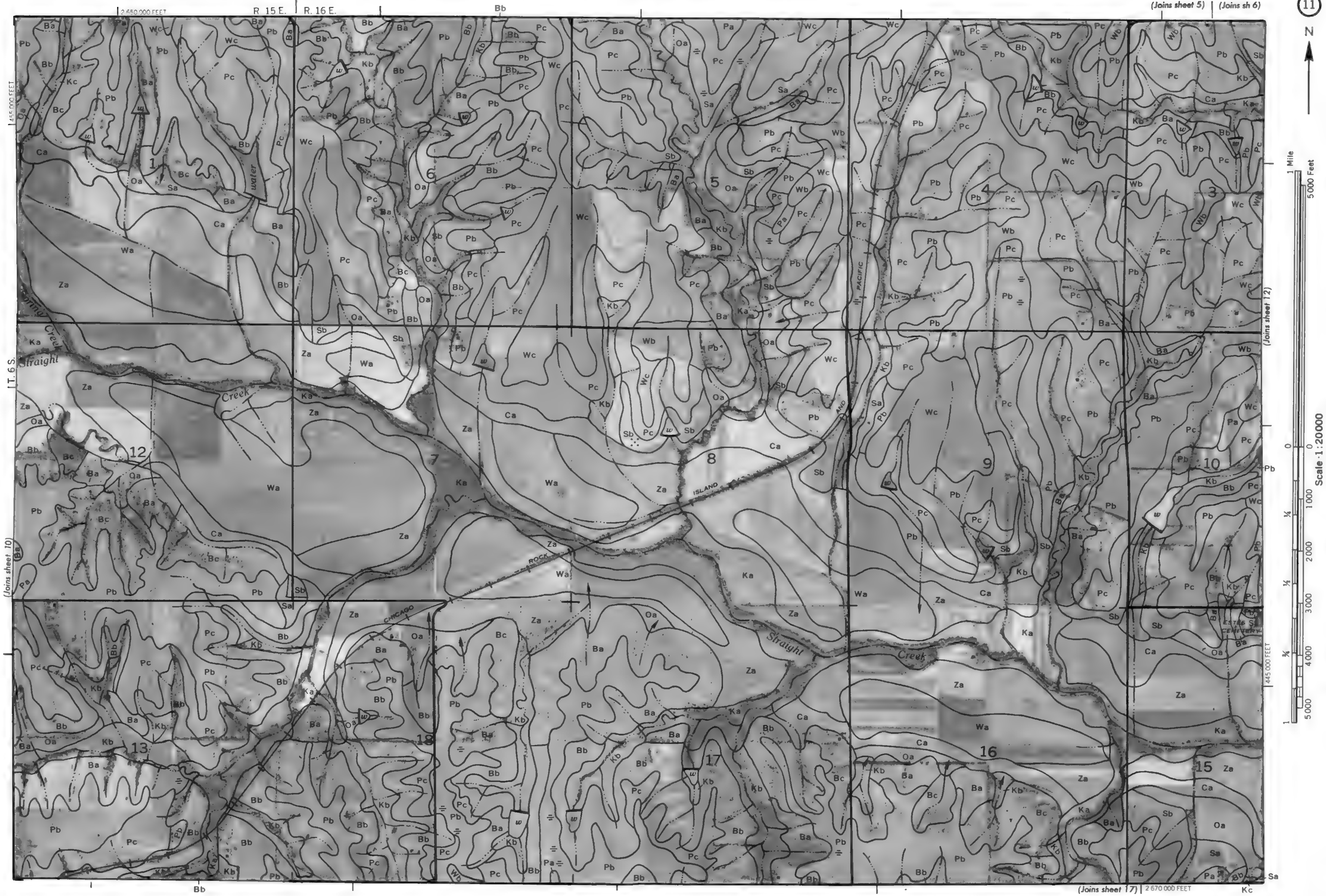

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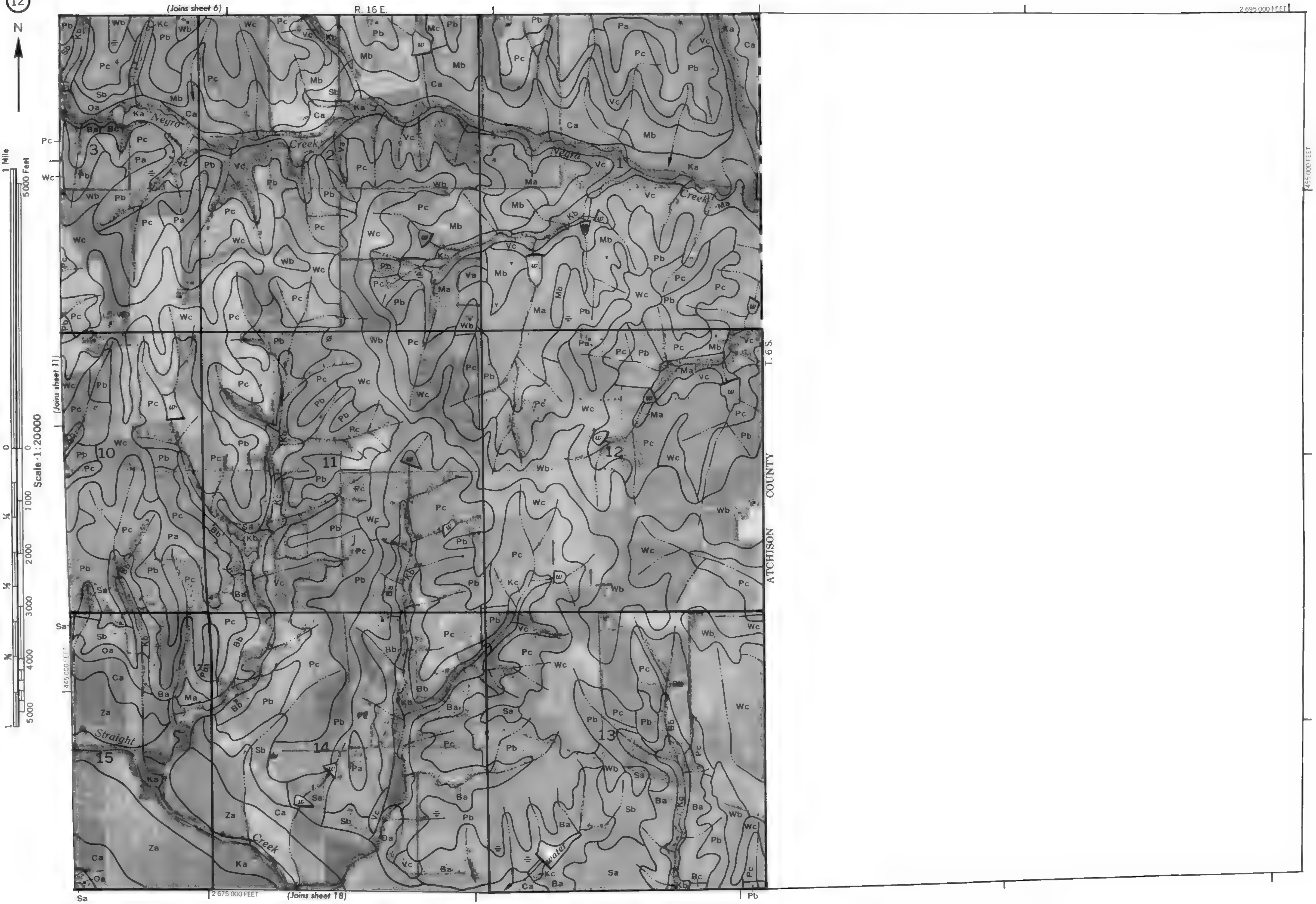

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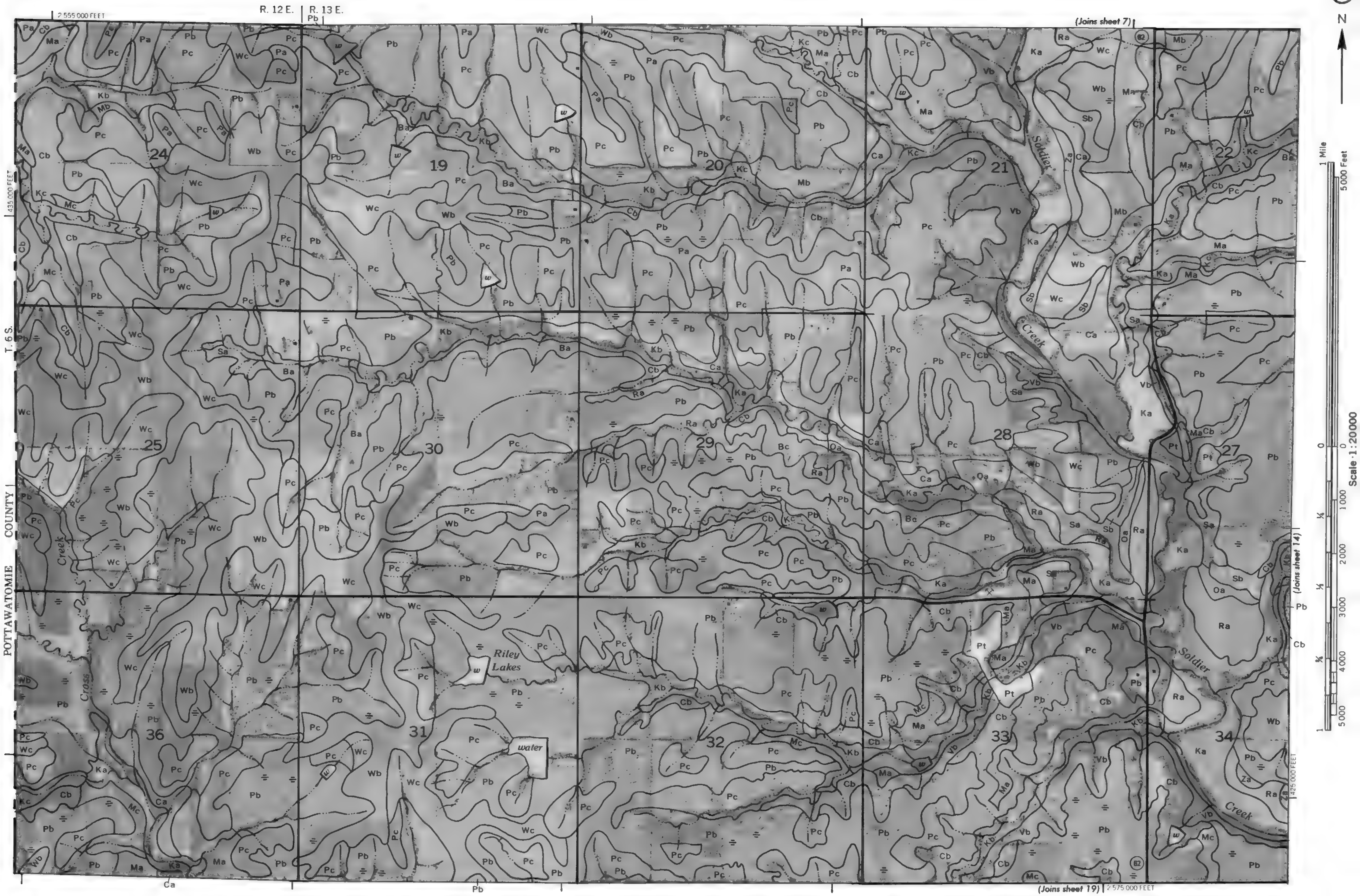

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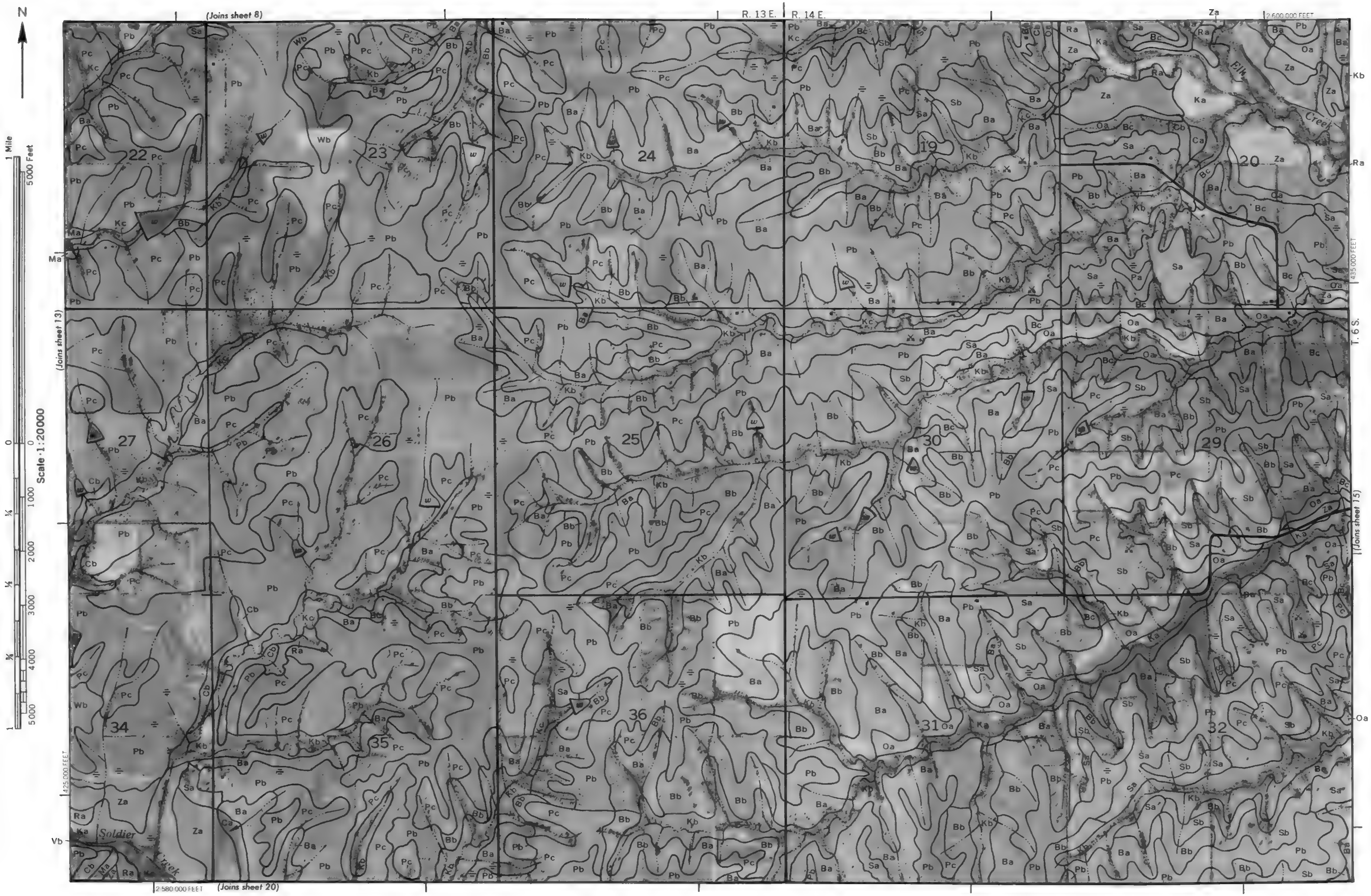

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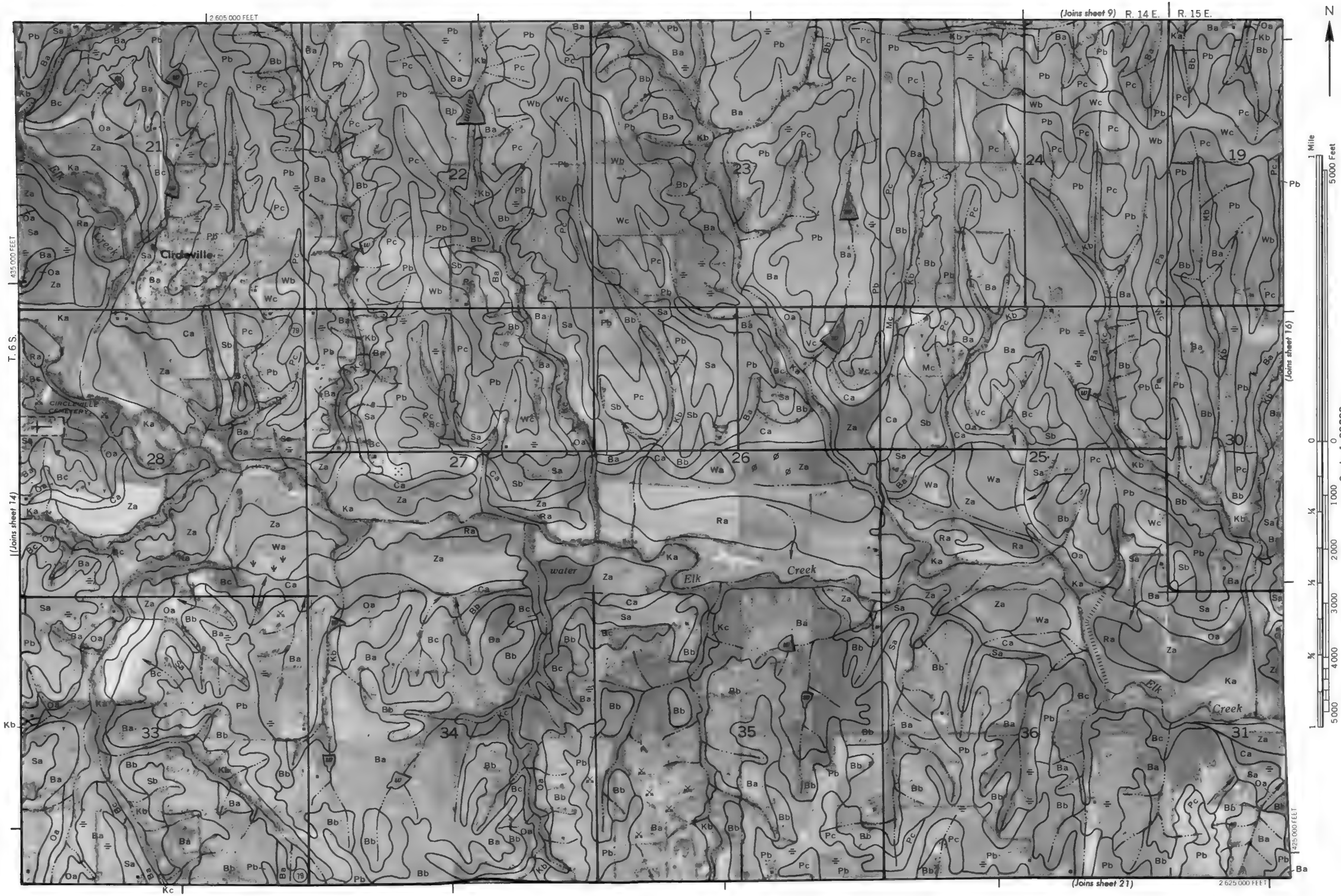

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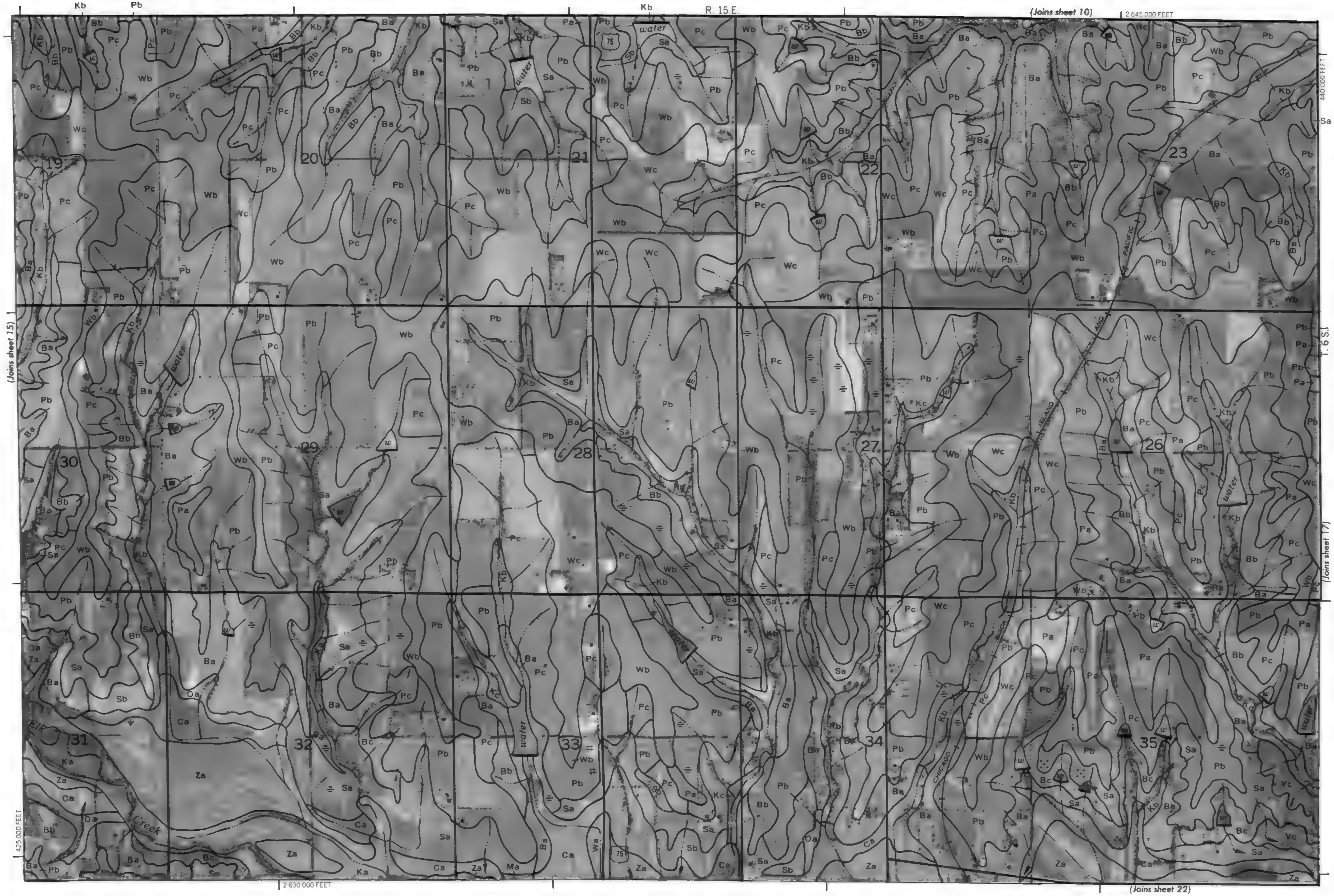
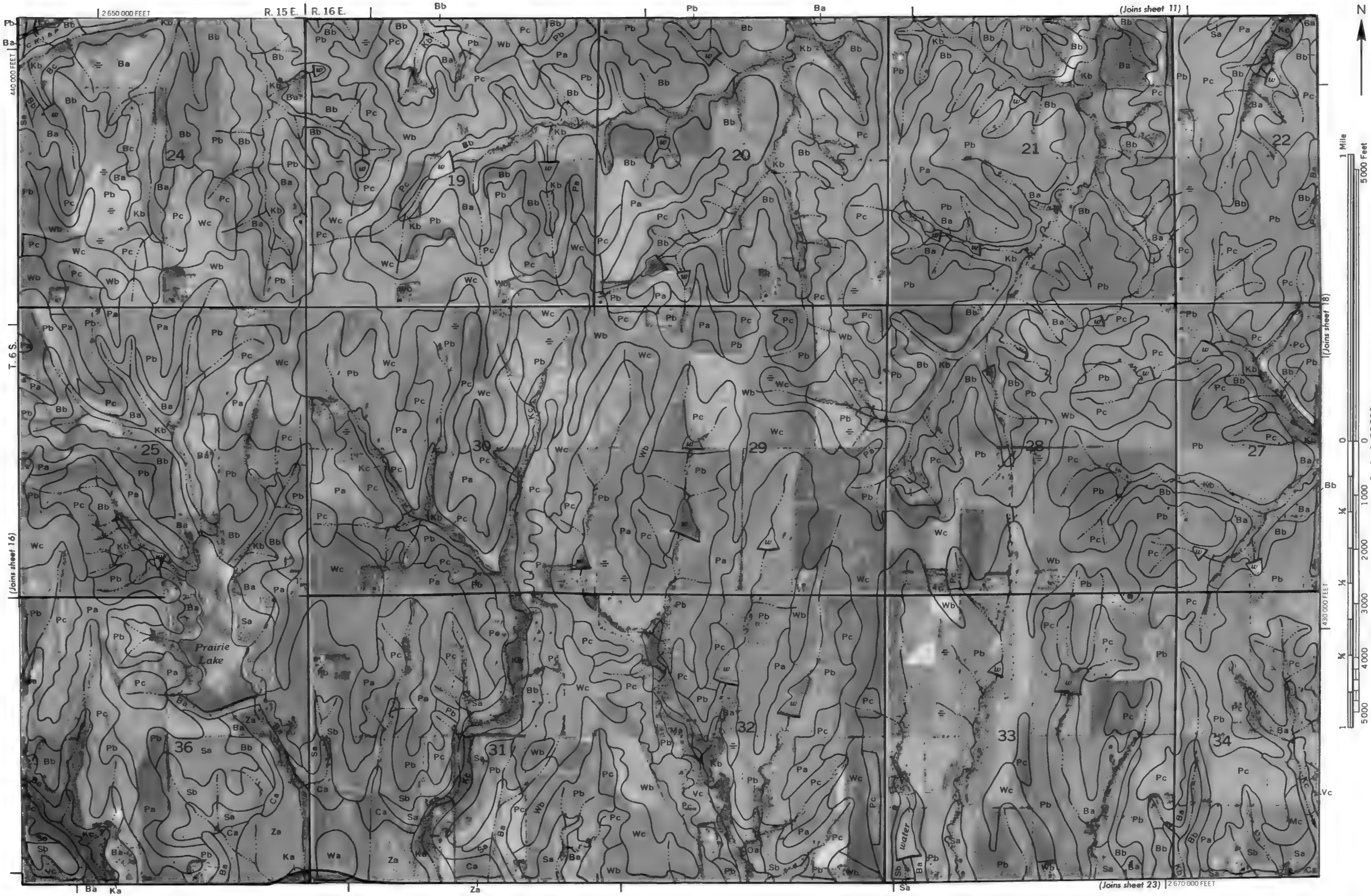
JACKSON COUNTY, KANSAS — SHEET NUMBER 16

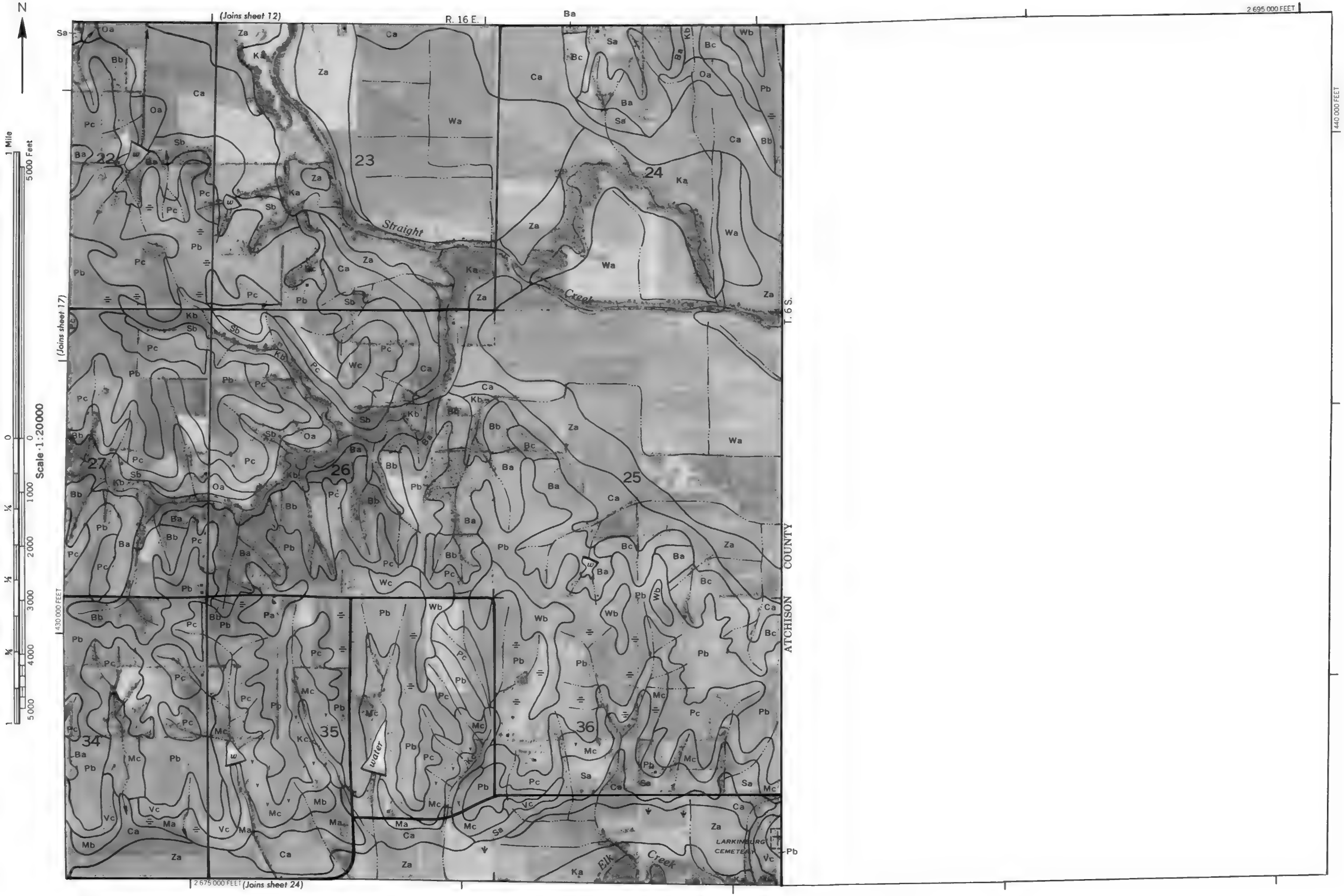


This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

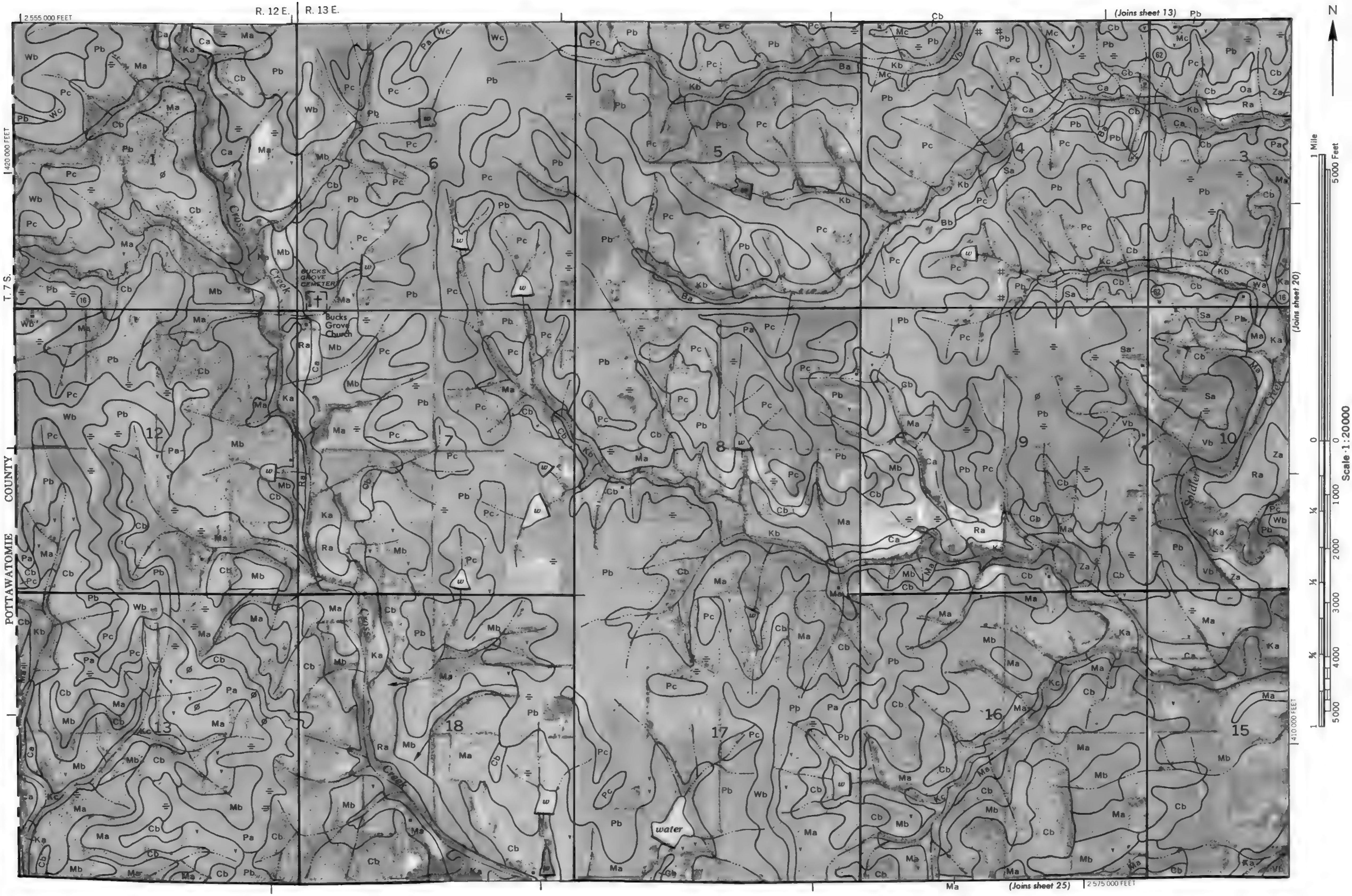


This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

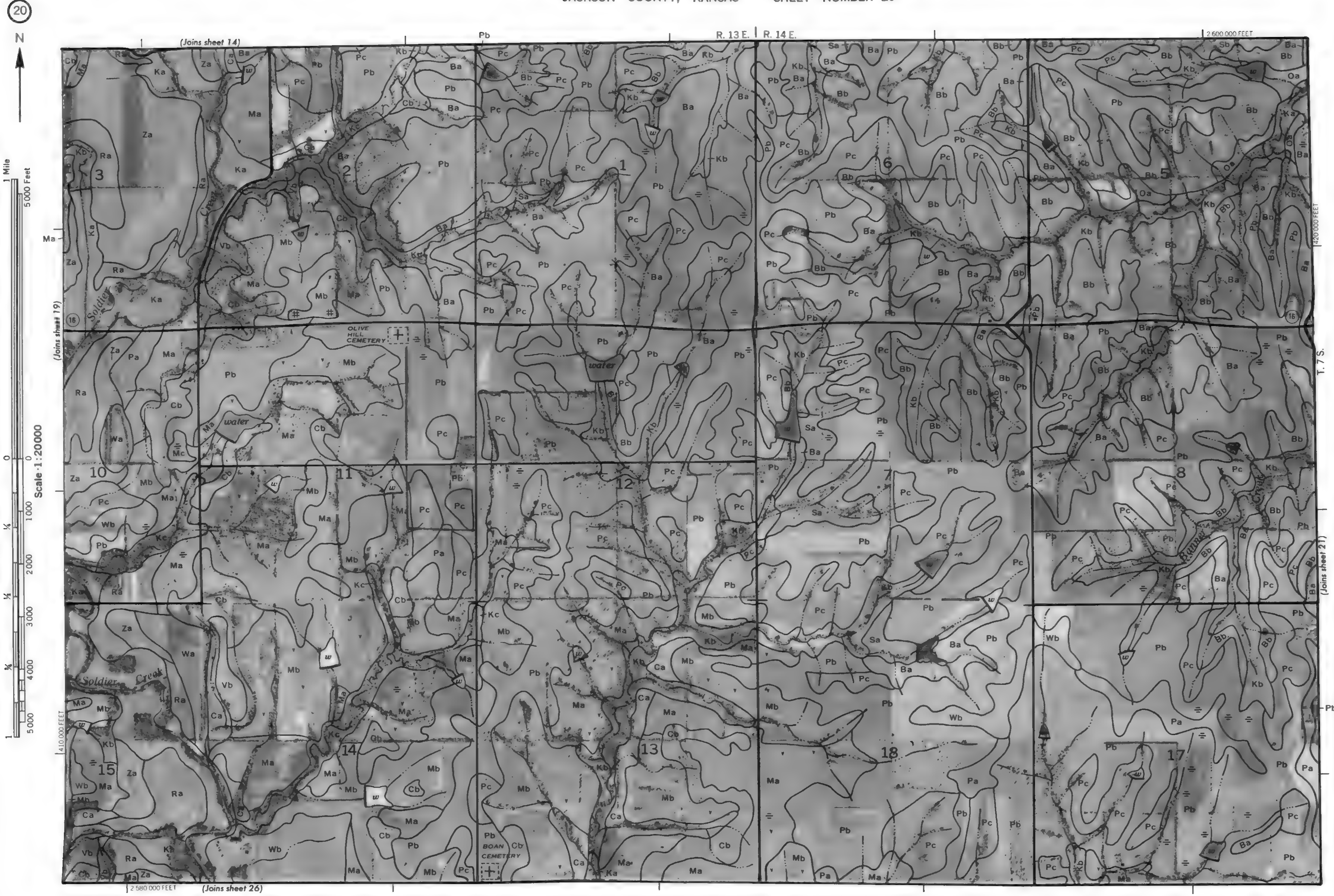
JACKSON COUNTY, KANSAS — SHEET NUMBER 18



This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned

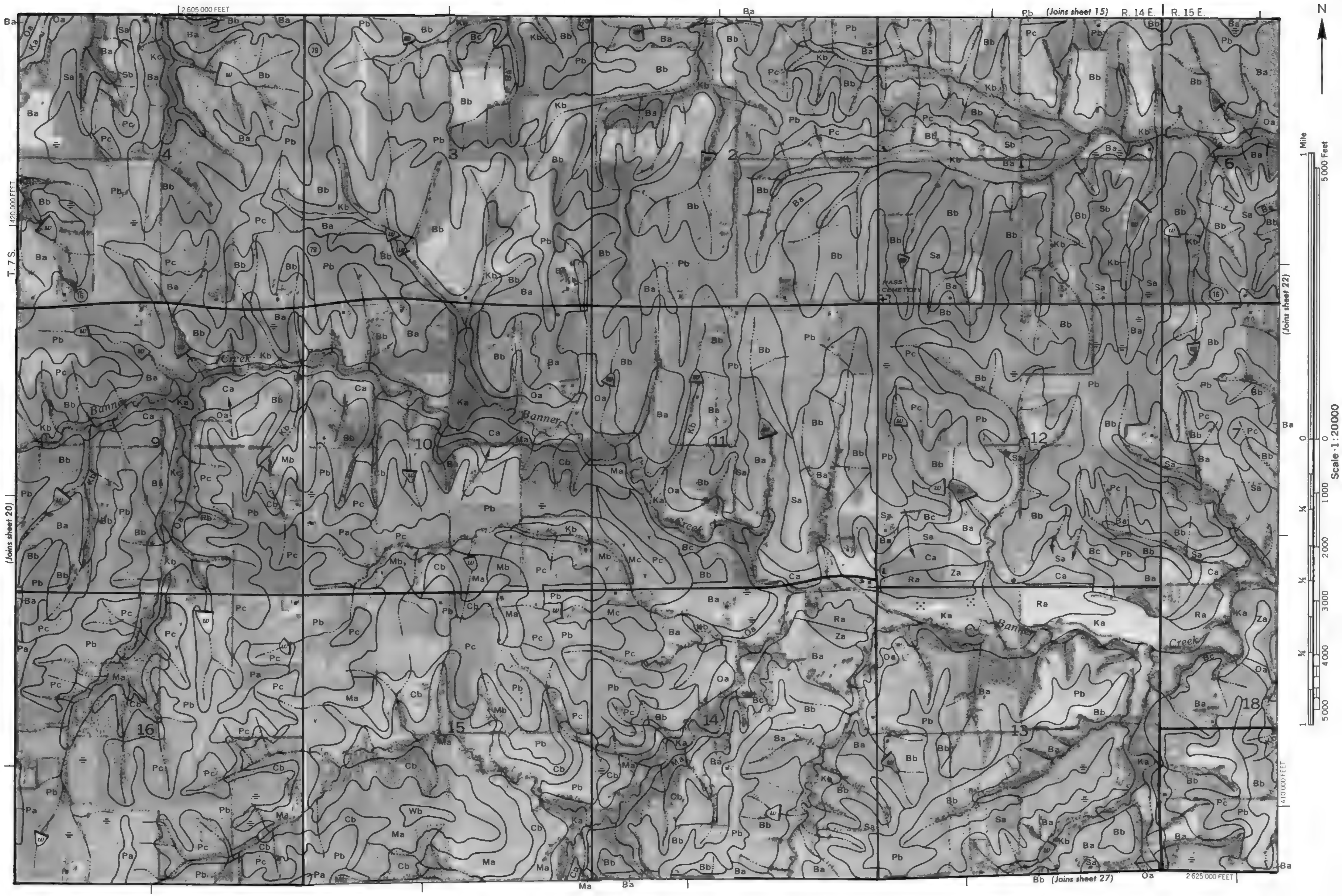


This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



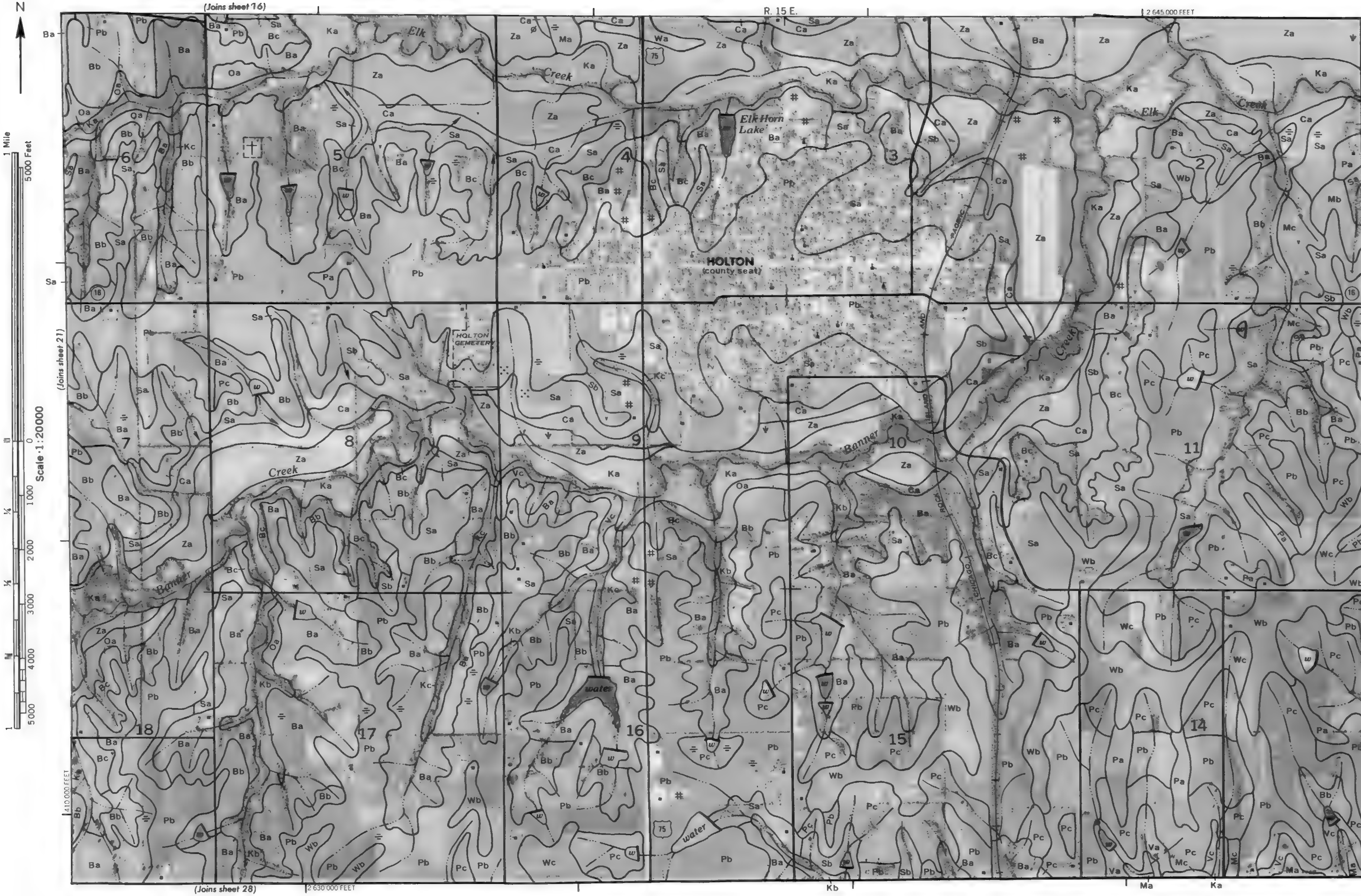
This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

JACKSON COUNTY, KANSAS — SHEET NUMBER 21



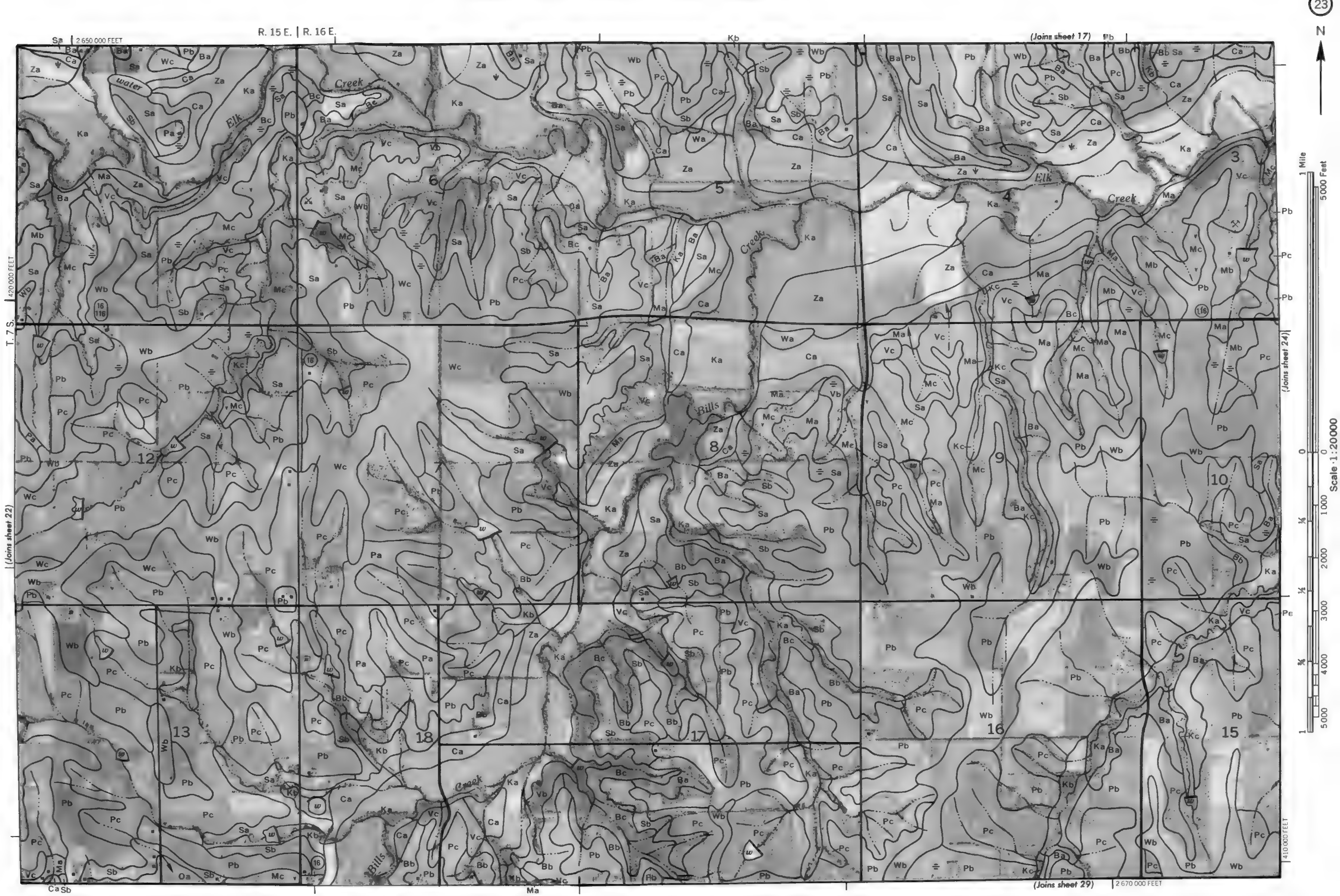
This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

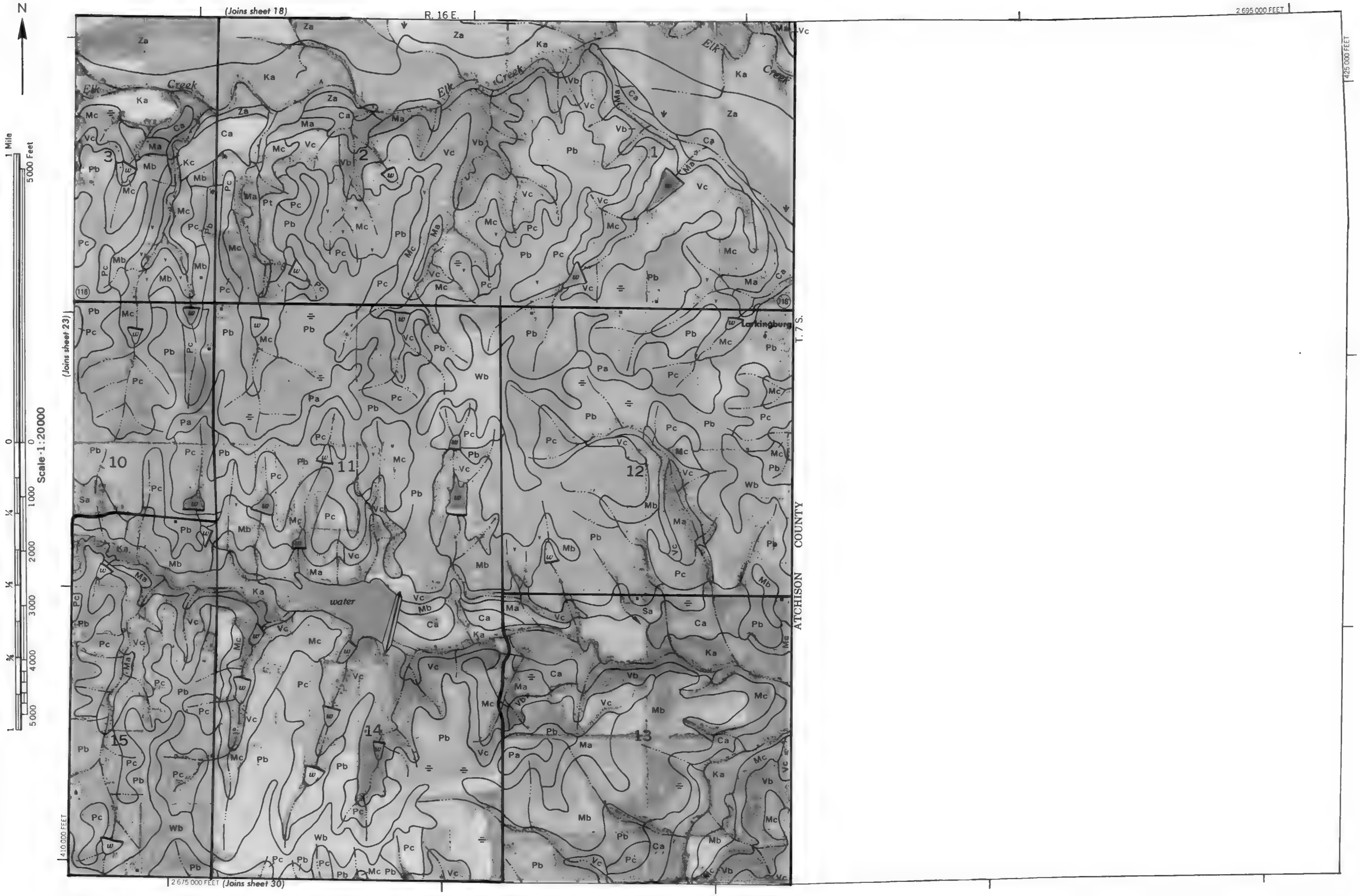
JACKSON COUNTY, KANSAS — SHEET NUMBER 22



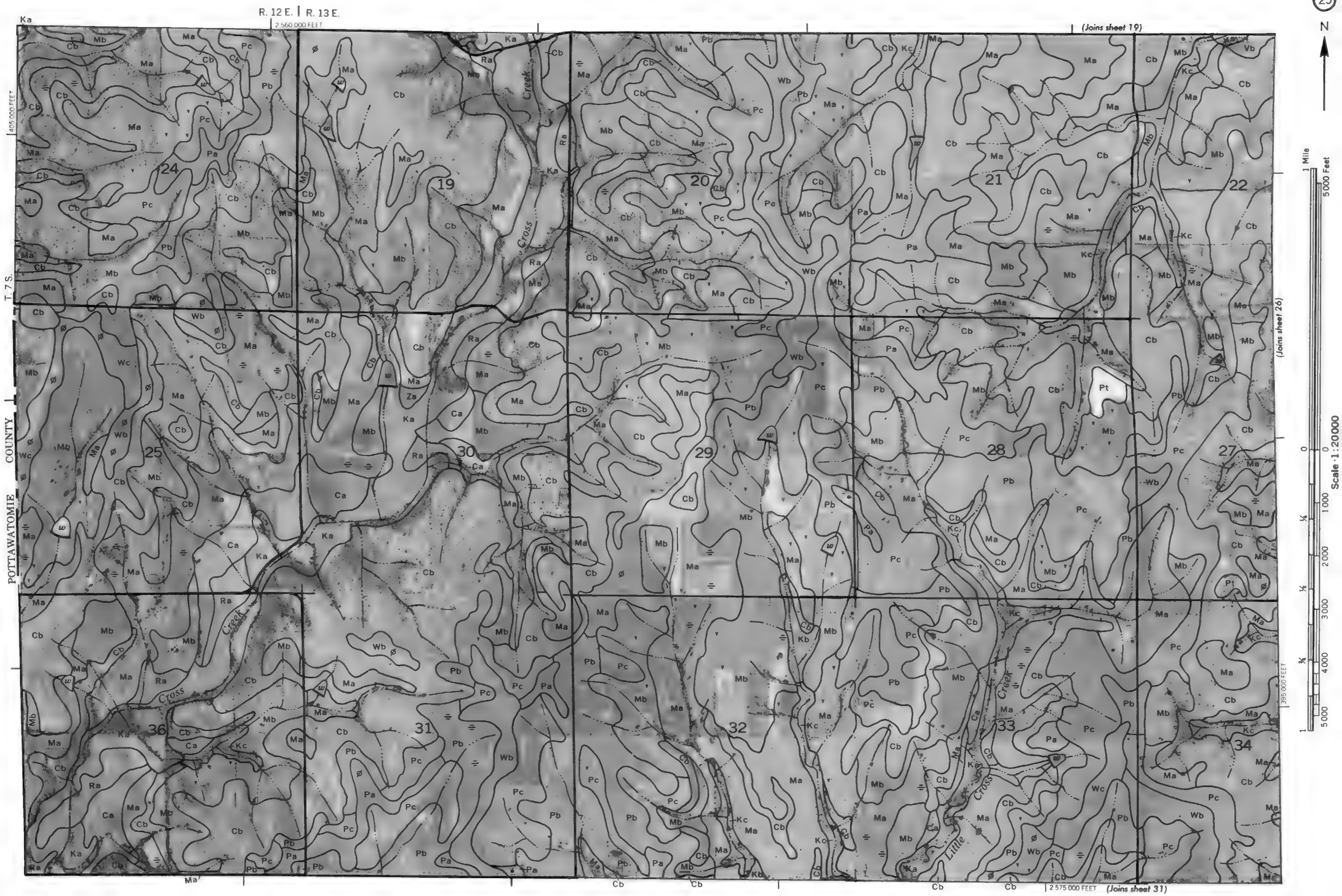
This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

JACKSON COUNTY, KANSAS — SHEET NUMBER 23



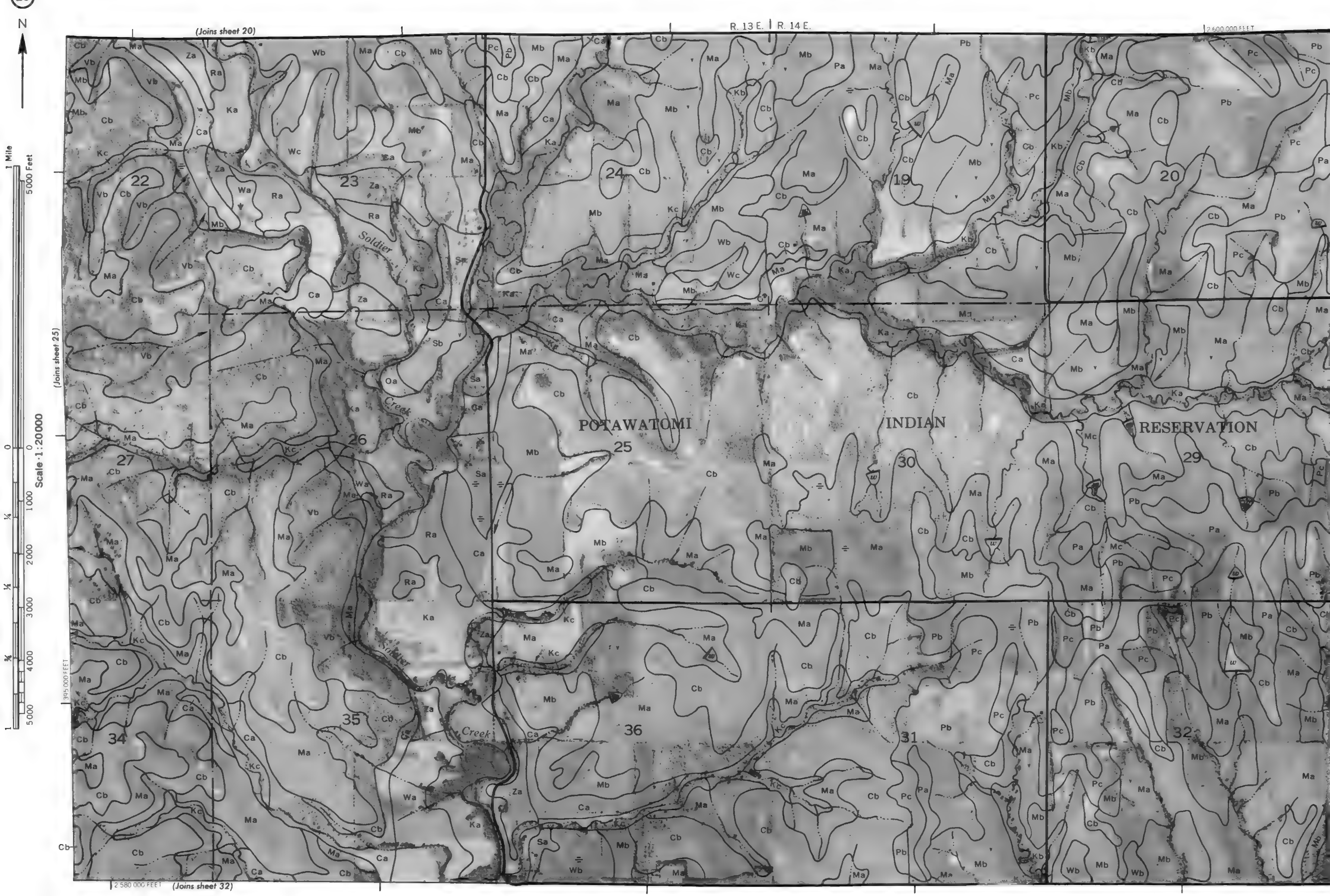


This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

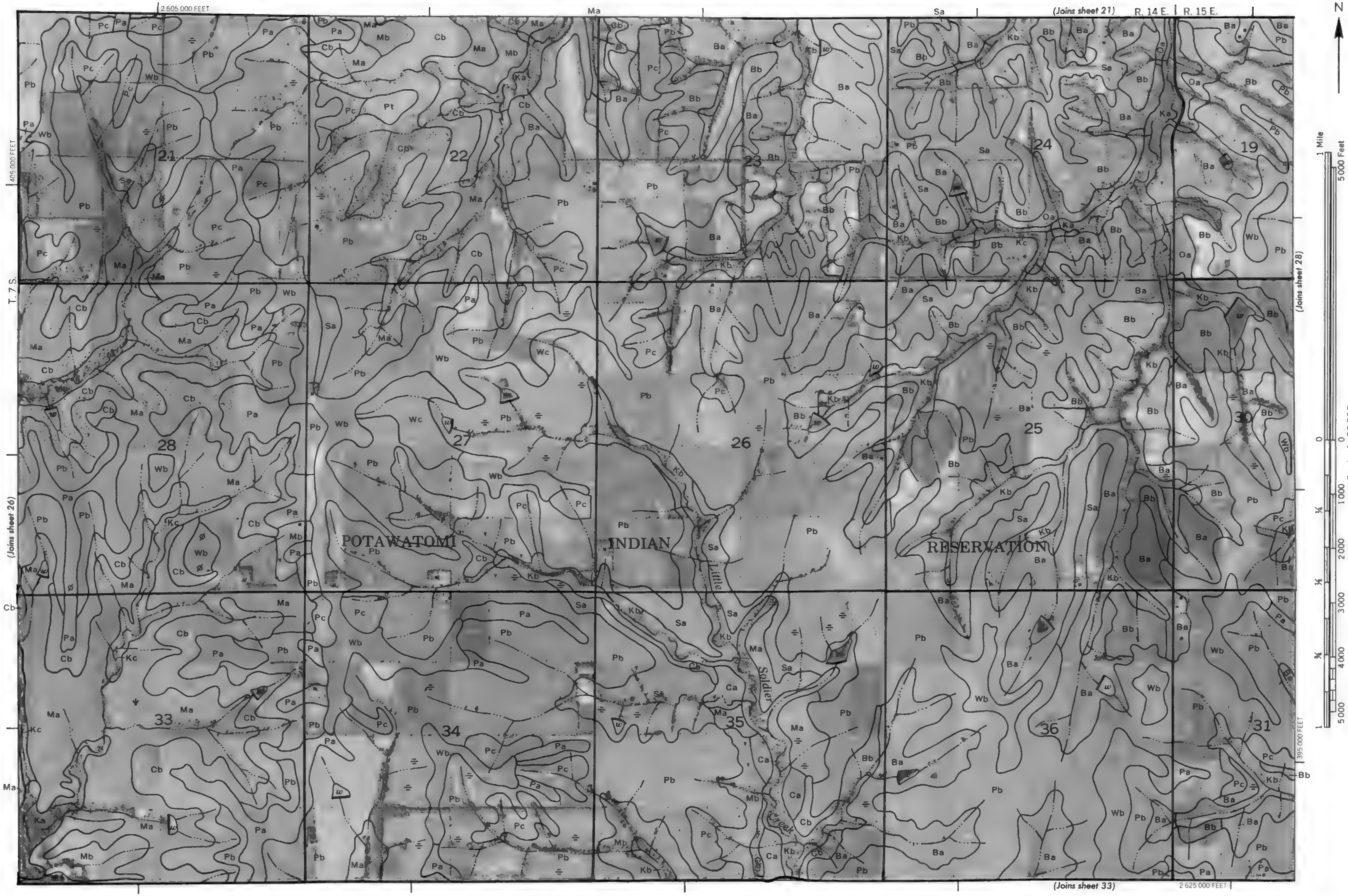


This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

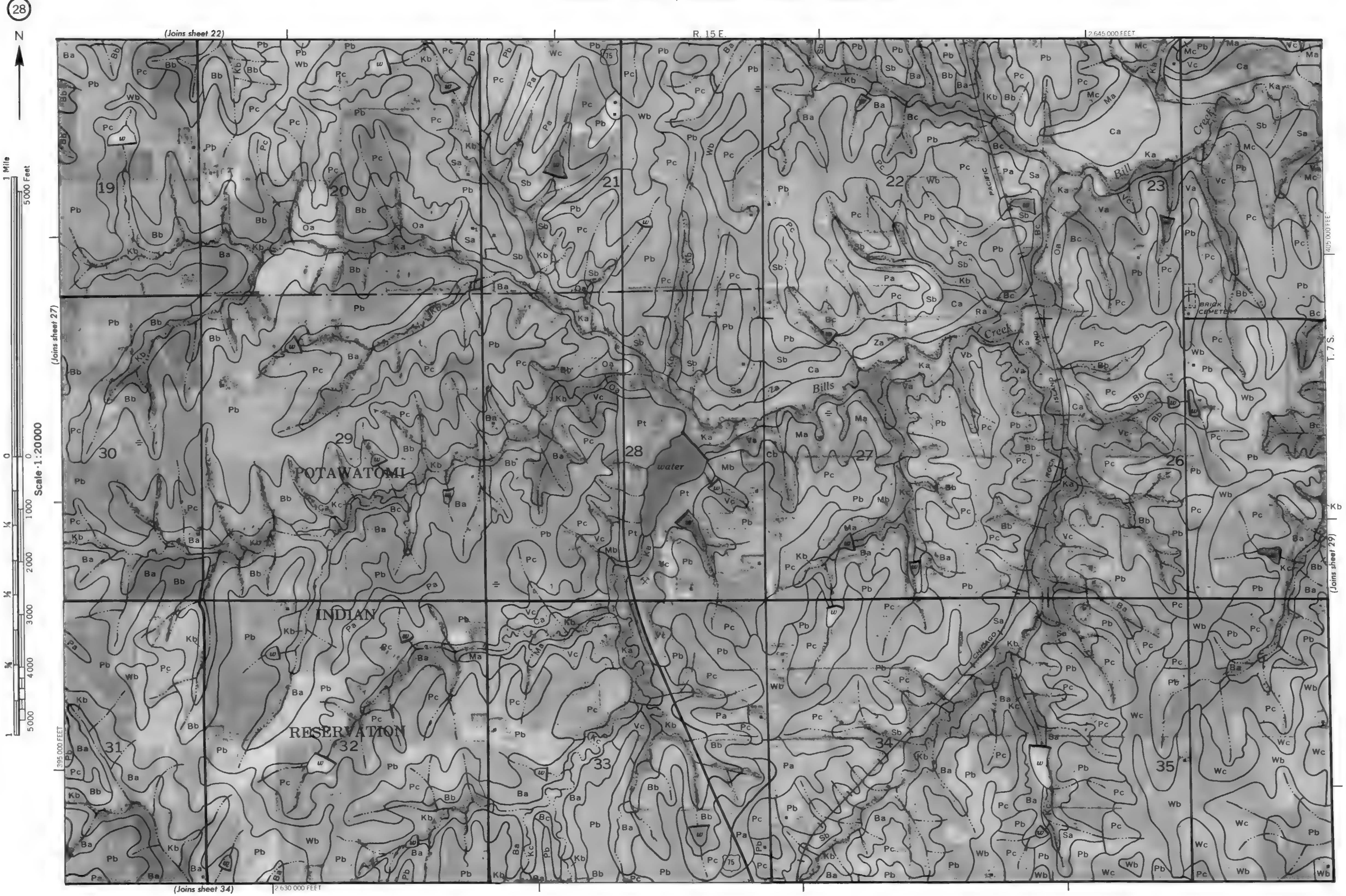
JACKSON COUNTY, KANSAS — SHEET NUMBER 26



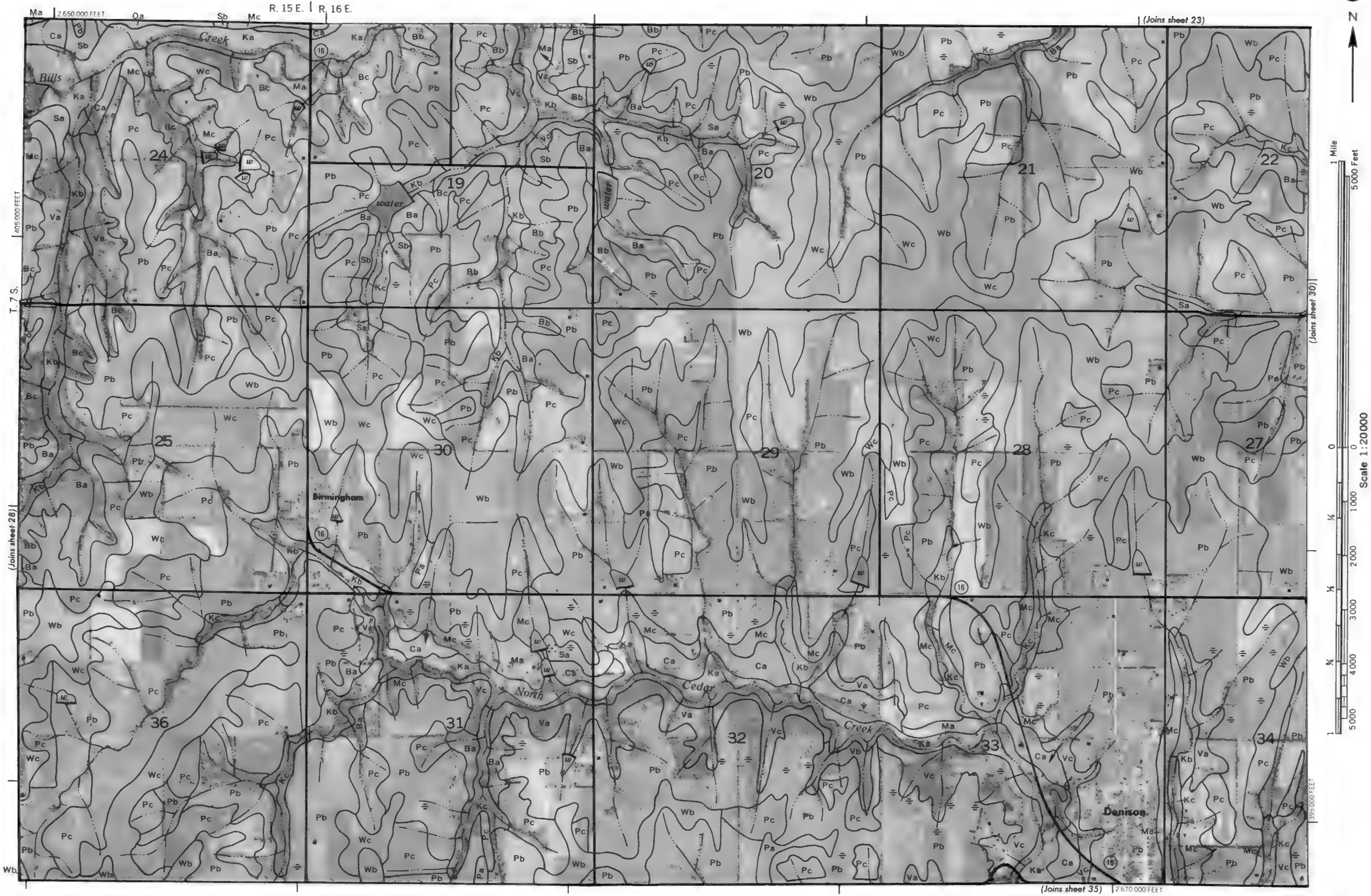
This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned


2 605 000 FEET
(Joins sheet 21)
R. 14 E.
R. 15 E.
N
405 000 FEET
T. 7 S.
(Joins sheet 26)
(Joins sheet 28)
(Joins sheet 33)
2 625 000 FEET
395 000 FEET
POTAWATOMI
INDIAN
RESERVATION
Little
Soldier
Creek
21
22
23
24
19
28
27
26
25
30
33
34
35
36
31
1 Mile
5000 Feet
Scale 1:20000

JACKSON COUNTY, KANSAS — SHEET NUMBER 28

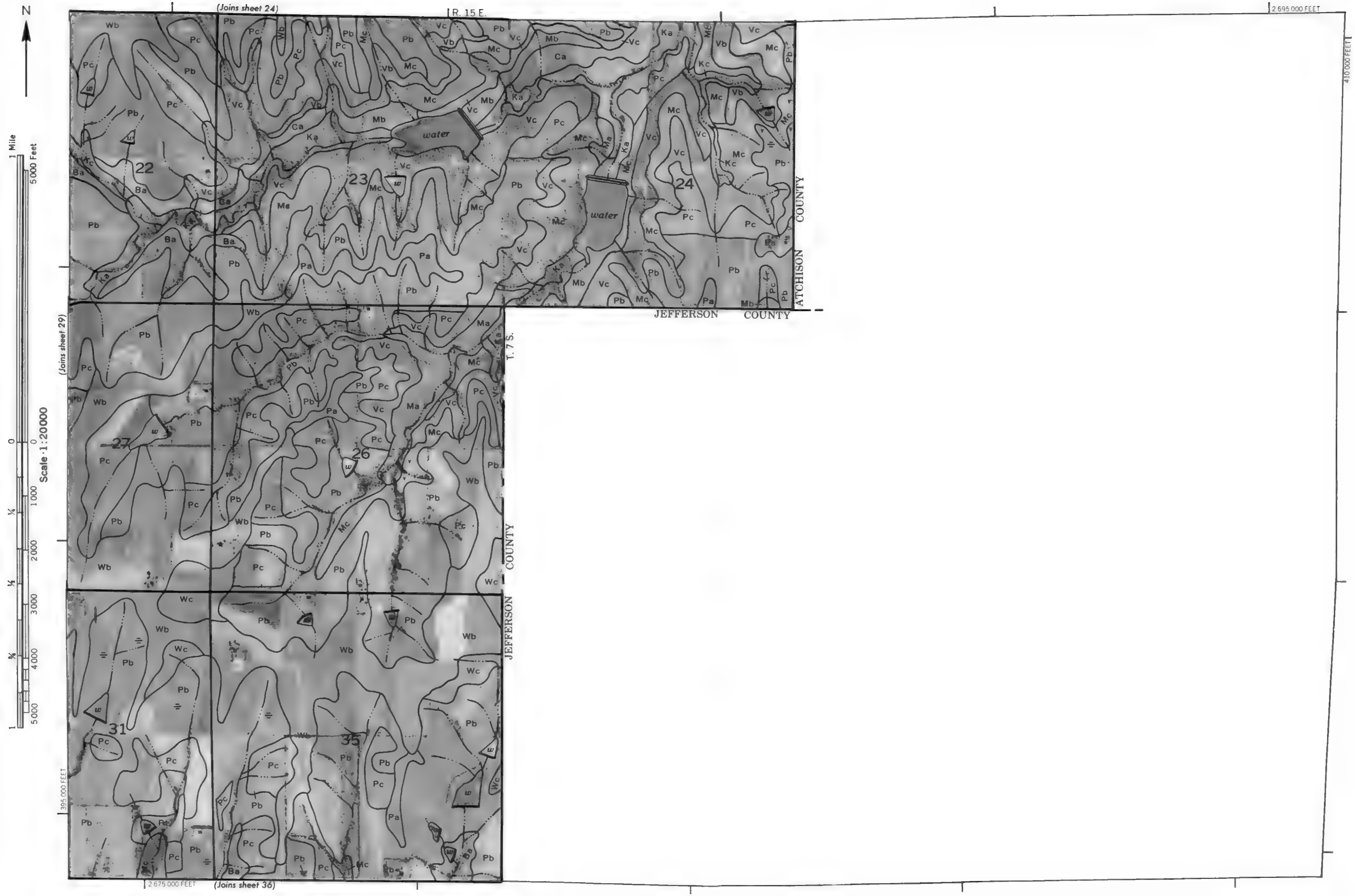


This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

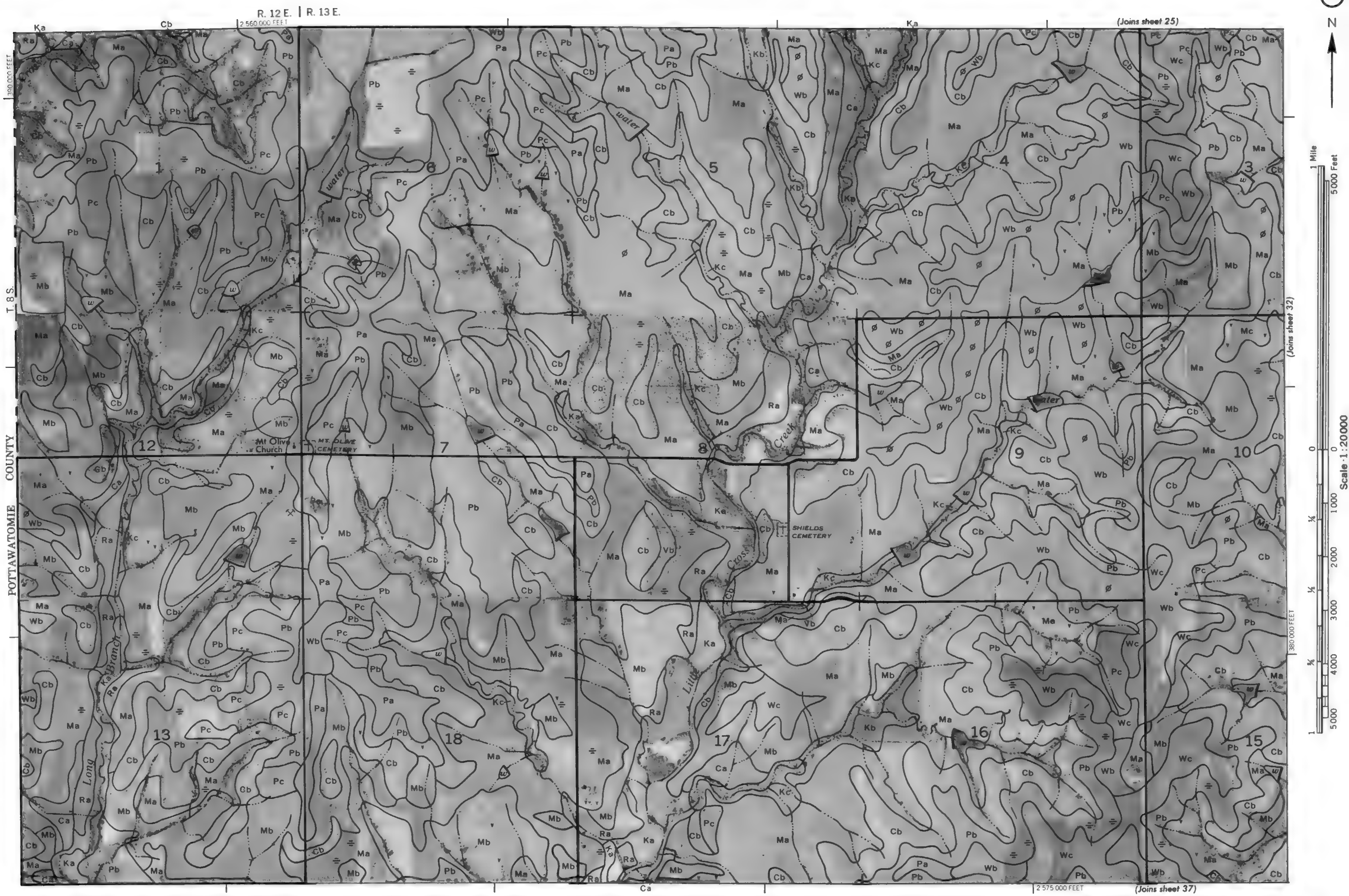


This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

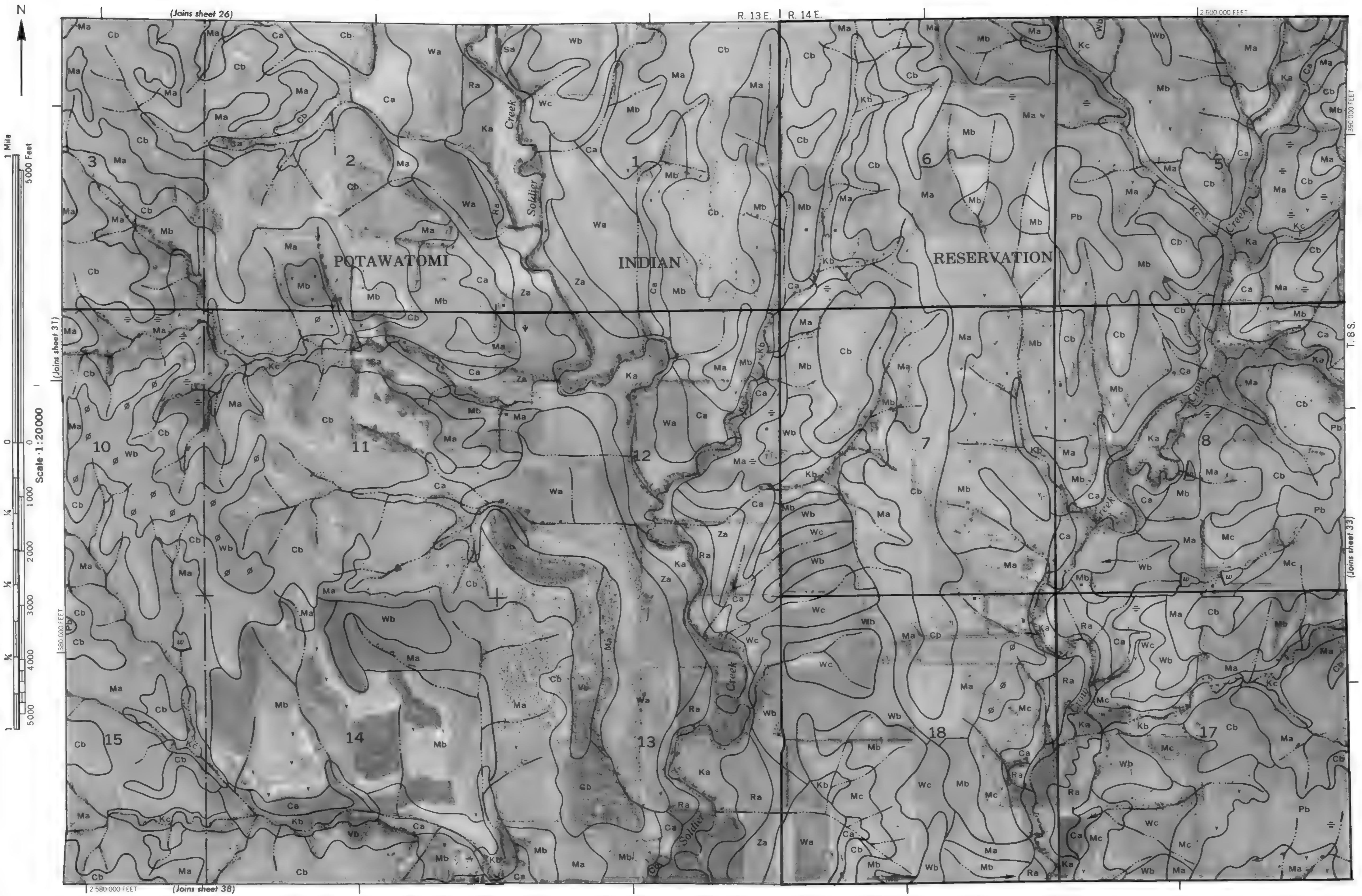
JACKSON COUNTY, KANSAS — SHEET NUMBER 30



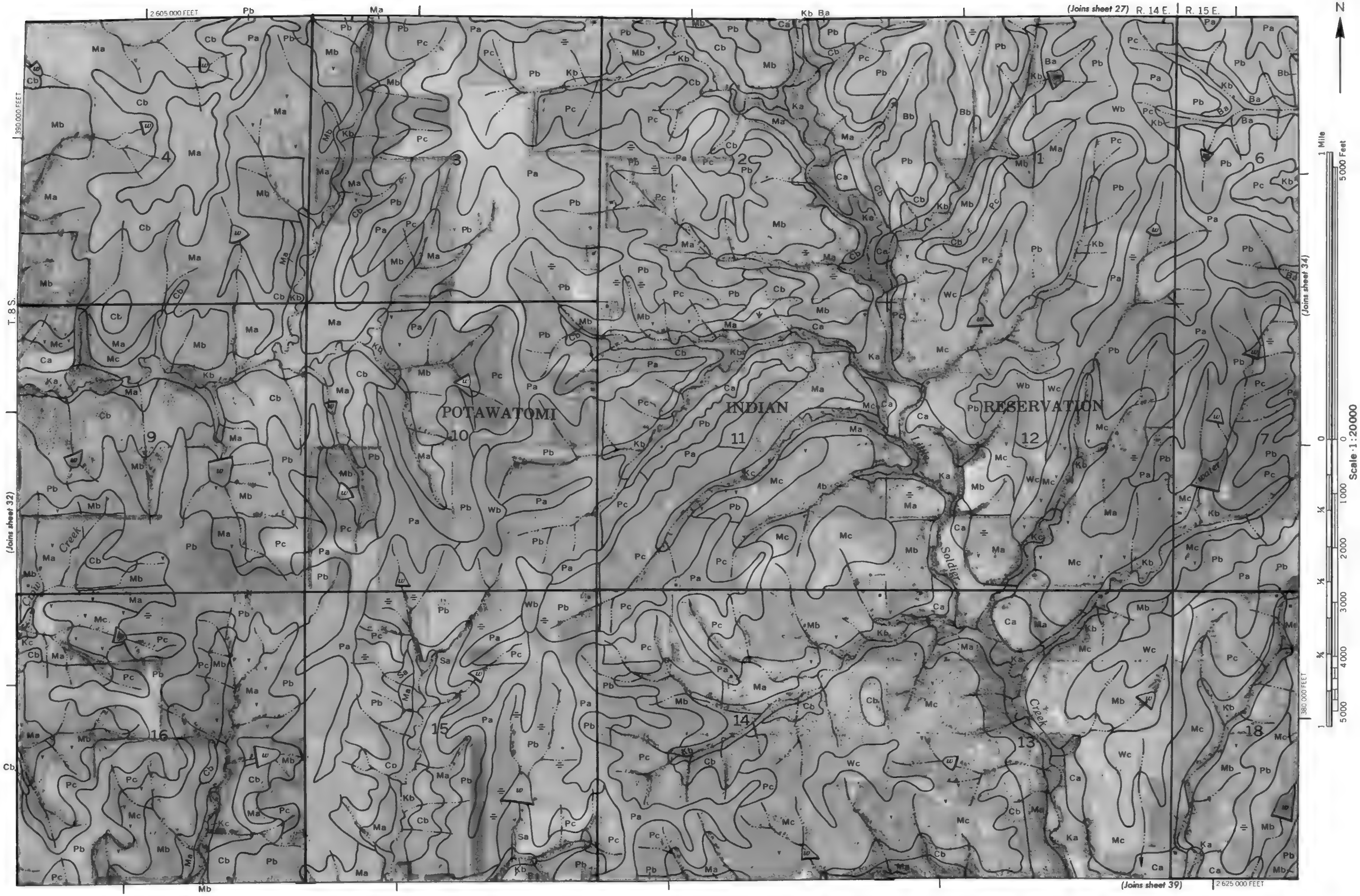
This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1975 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

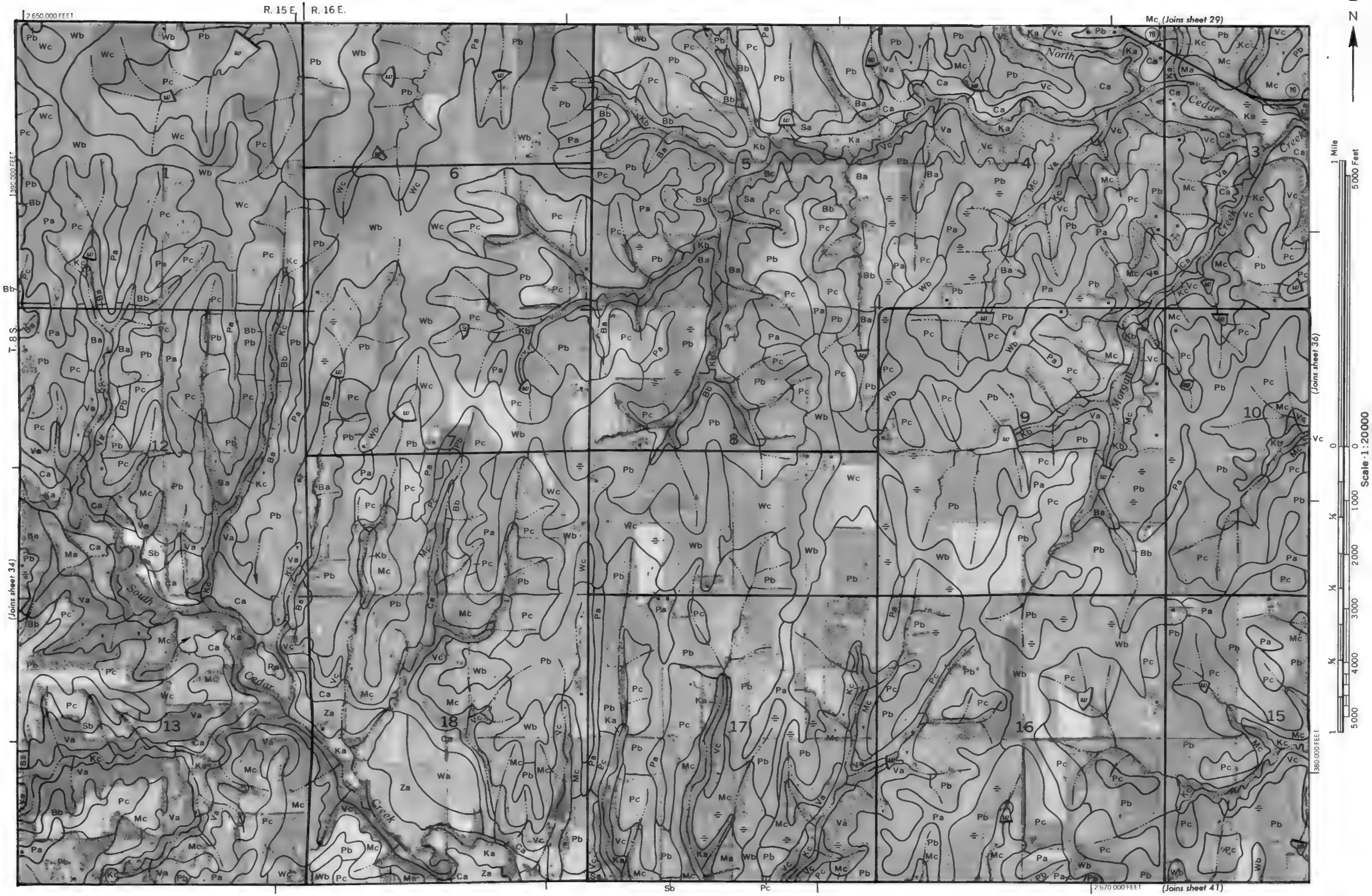


This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

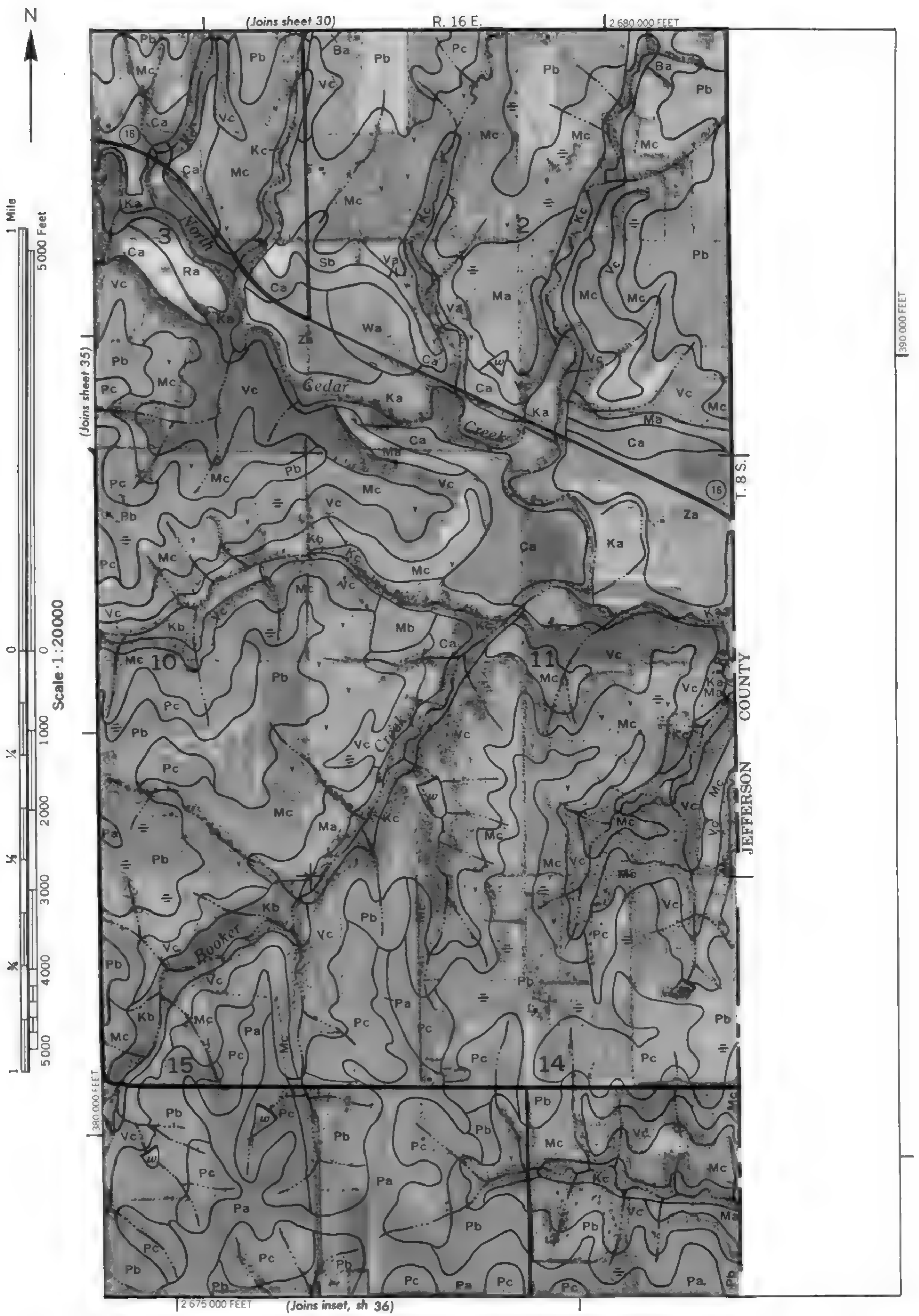


This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



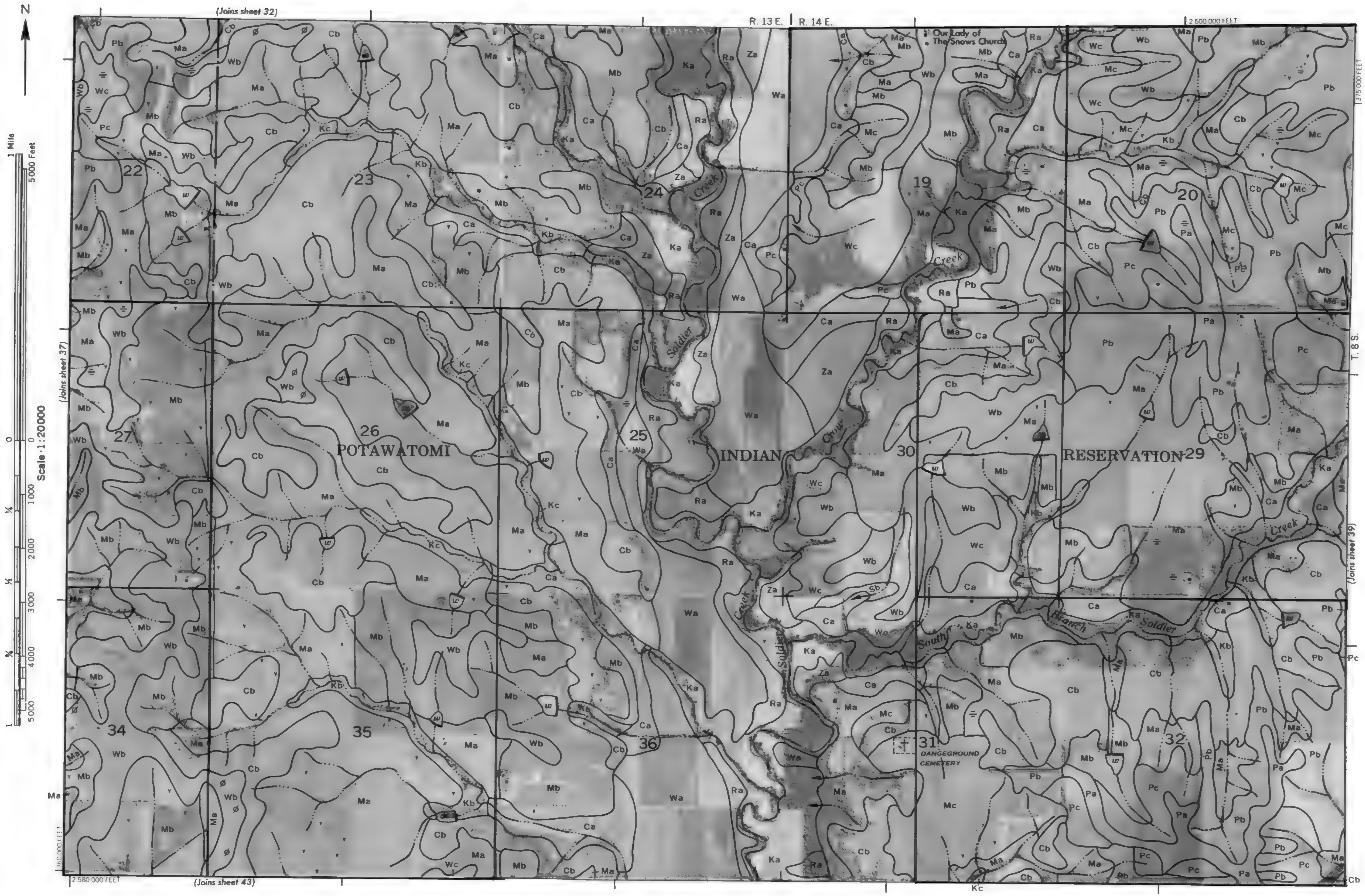
This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

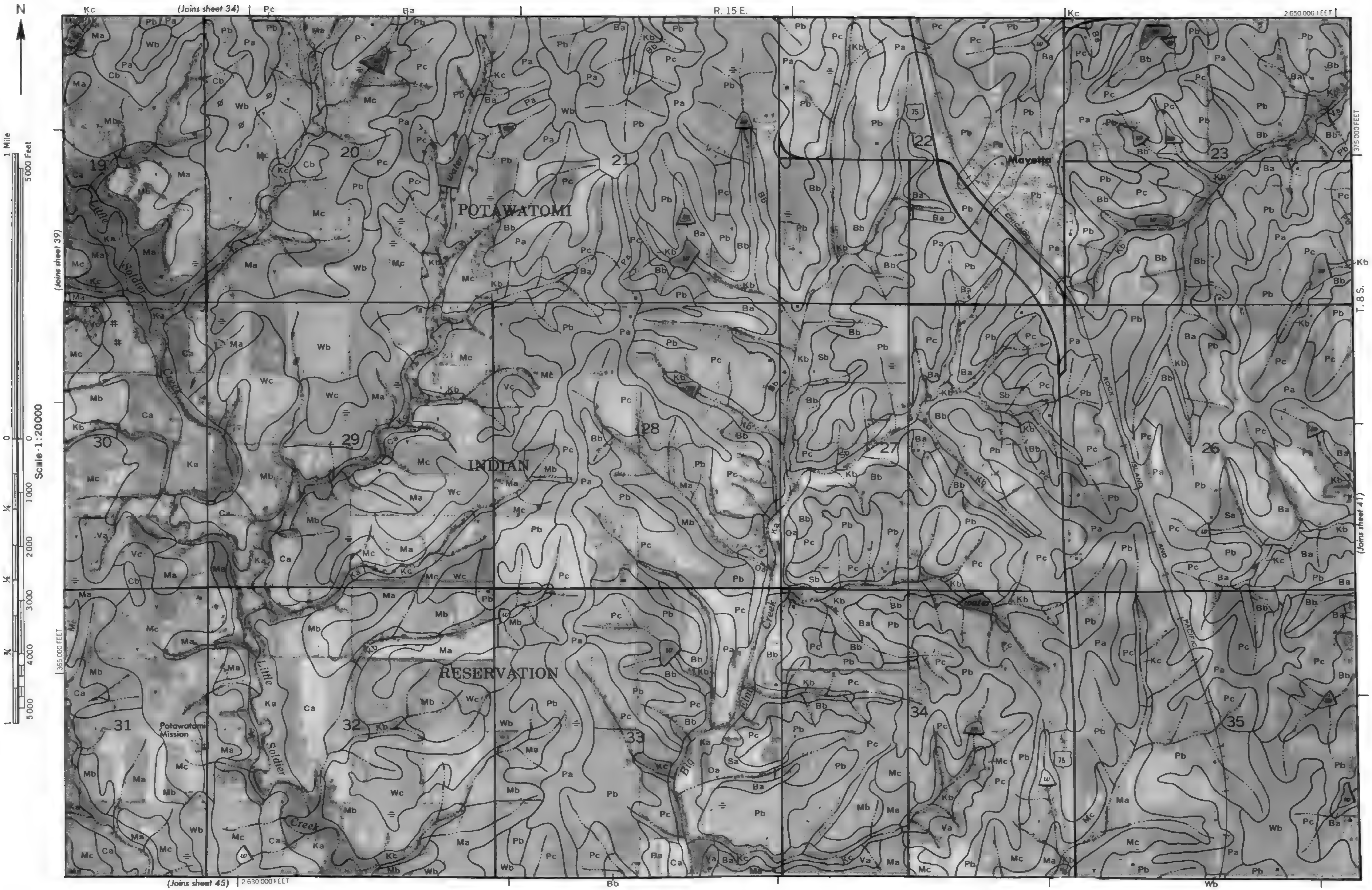
This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

JACKSON COUNTY, KANSAS — SHEET NUMBER 38

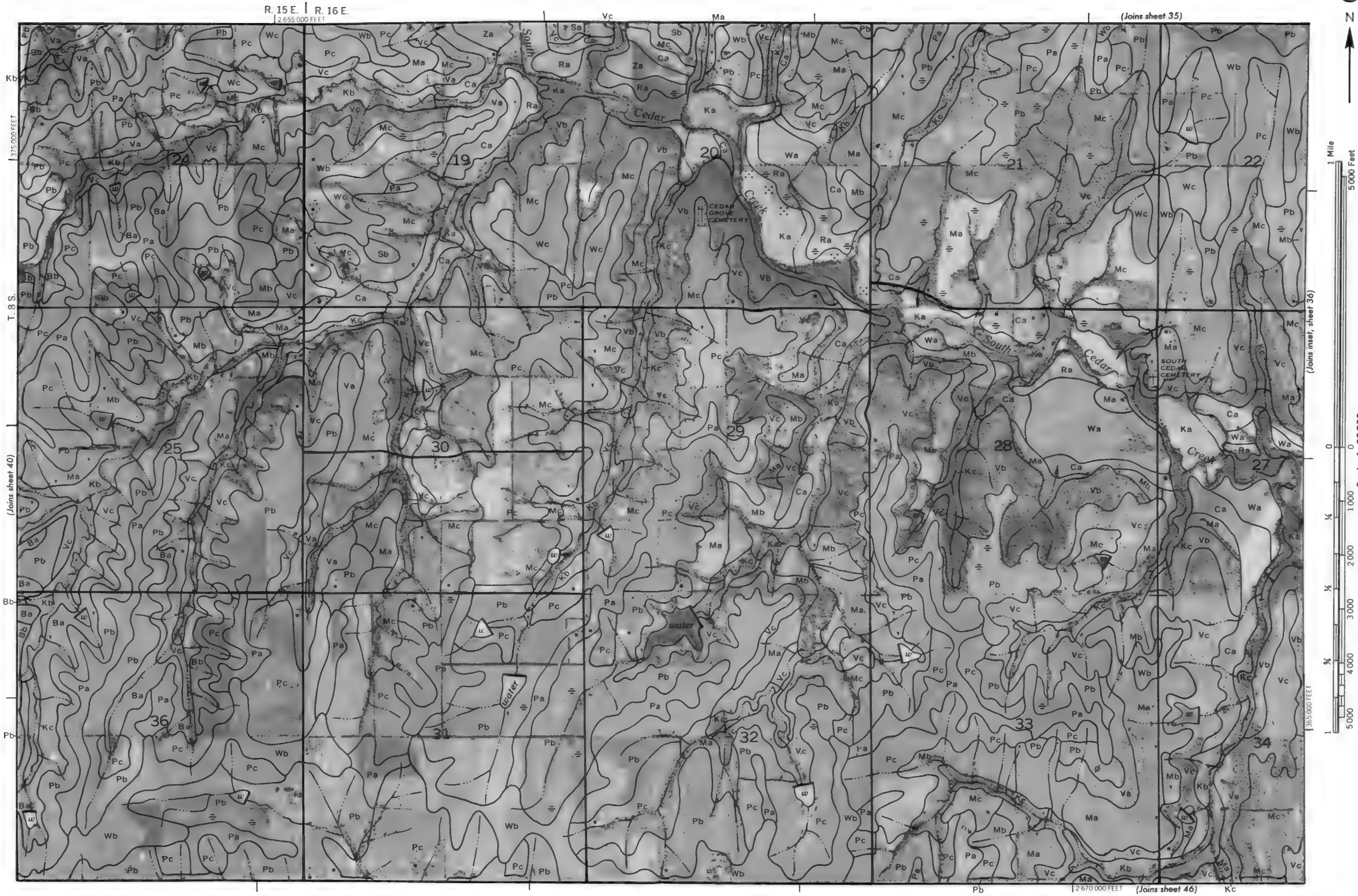


This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

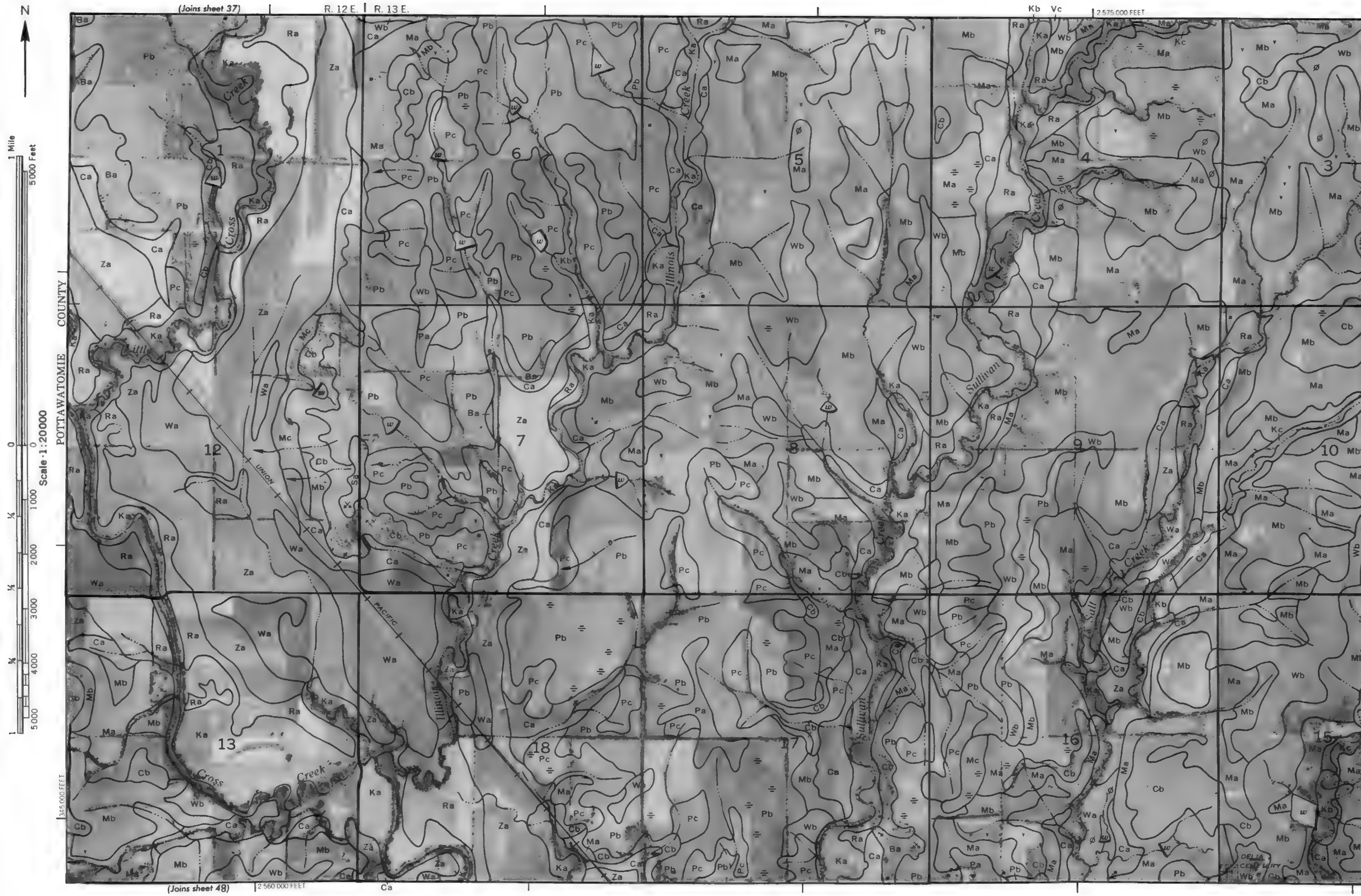
This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



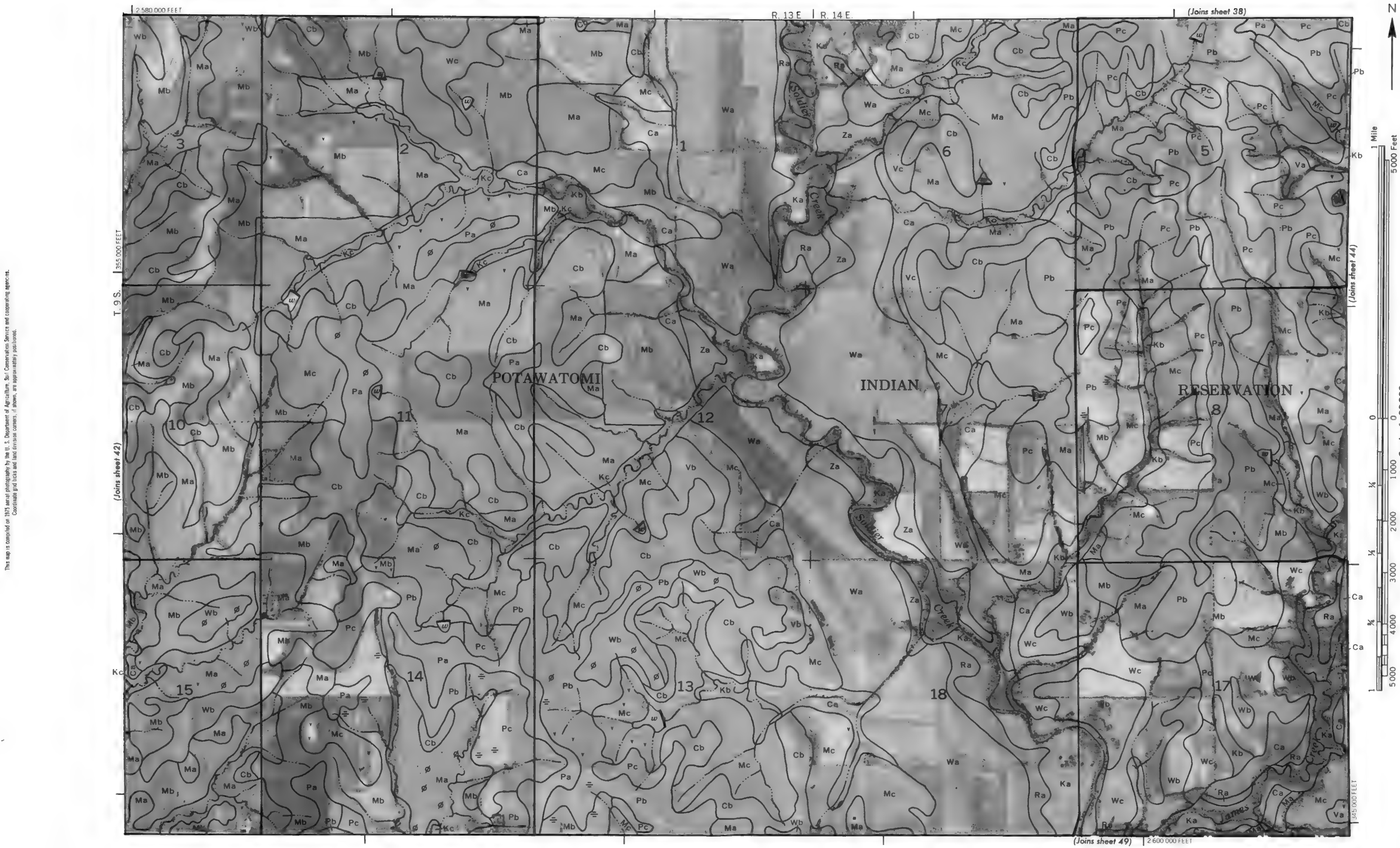
This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

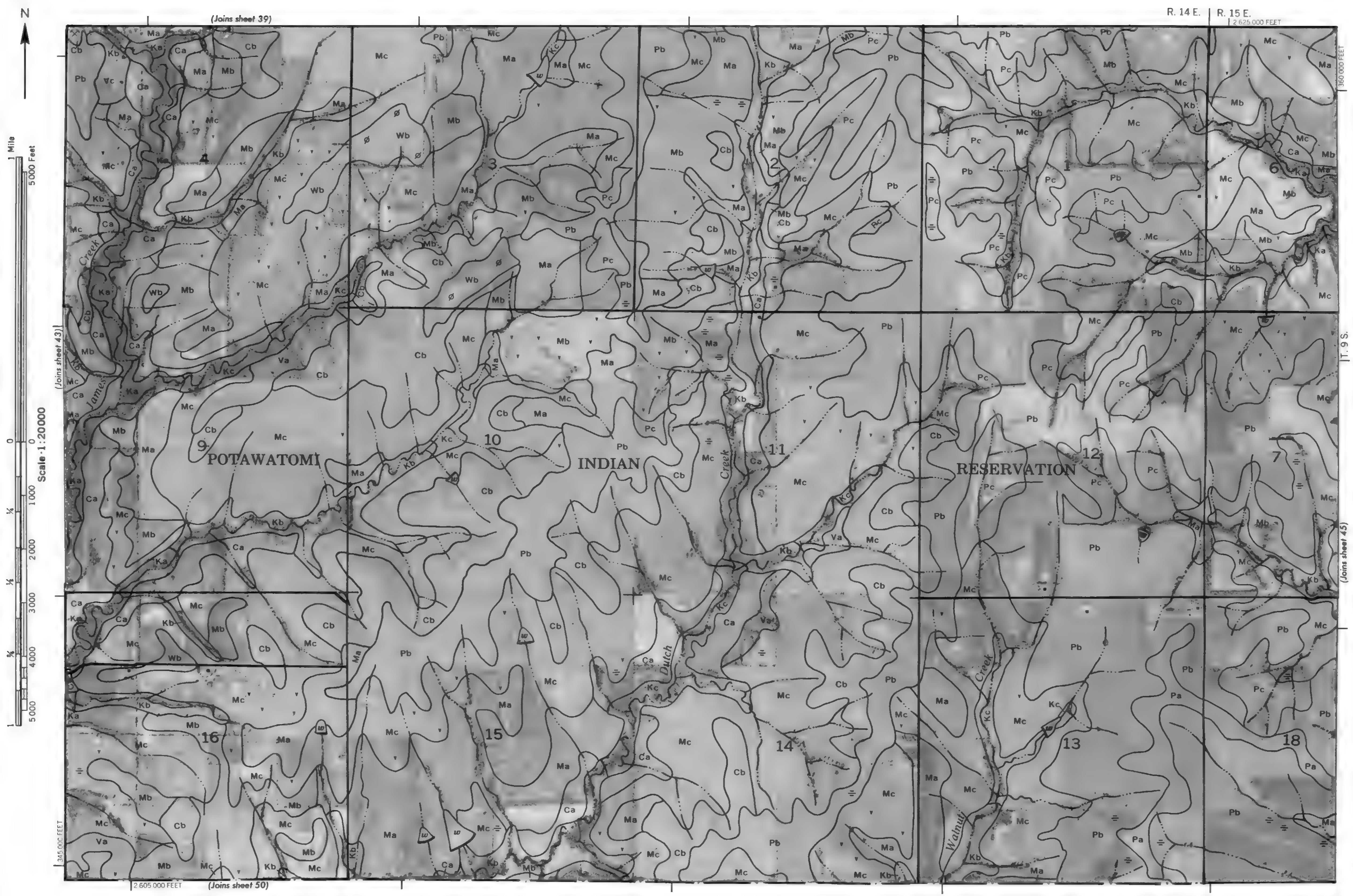


This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

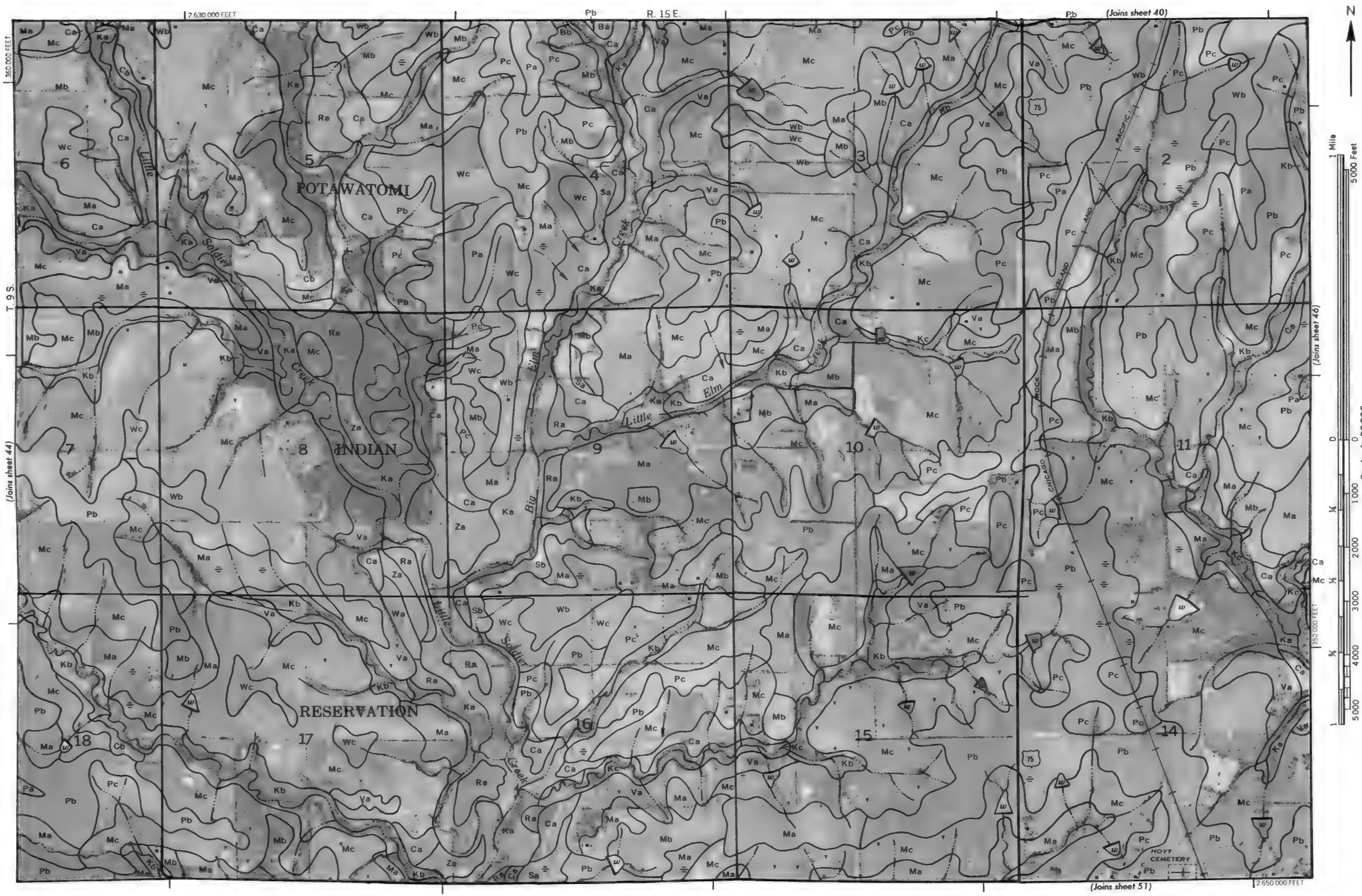


This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.


(Joins sheet 38)
(Joins sheet 44)
(Joins sheet 49)
(Joins sheet 42)
R. 13 E. | R. 14 E.
T. 9 S.
2 580 000 FEET
2 600 000 FEET
355 000 FEET
345 000 FEET
POTAWATOMI INDIAN RESERVATION
Soldier Creek
James Creek
N
1 Mile
5000 Feet
Scale 1:20000
This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

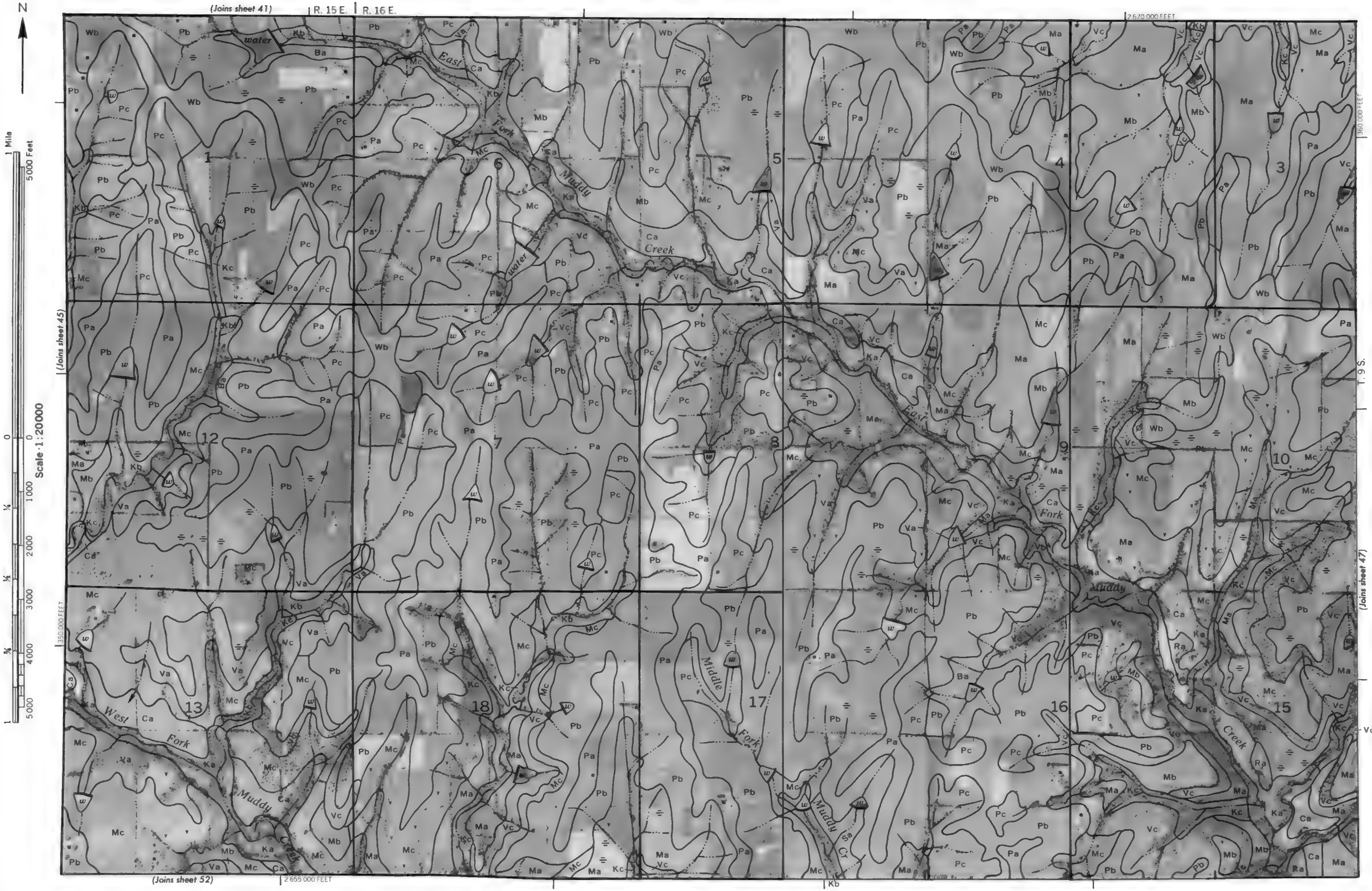


This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

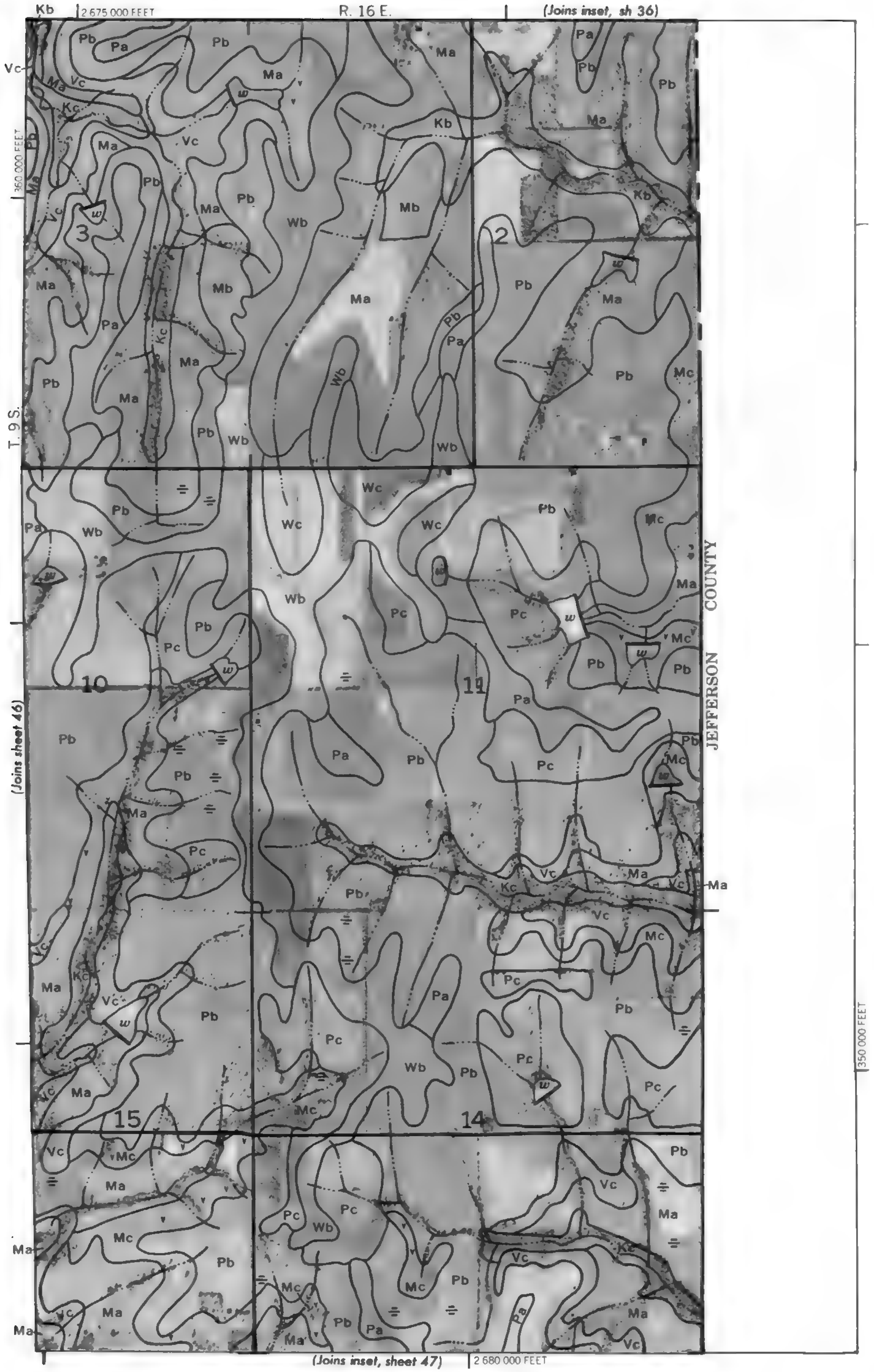


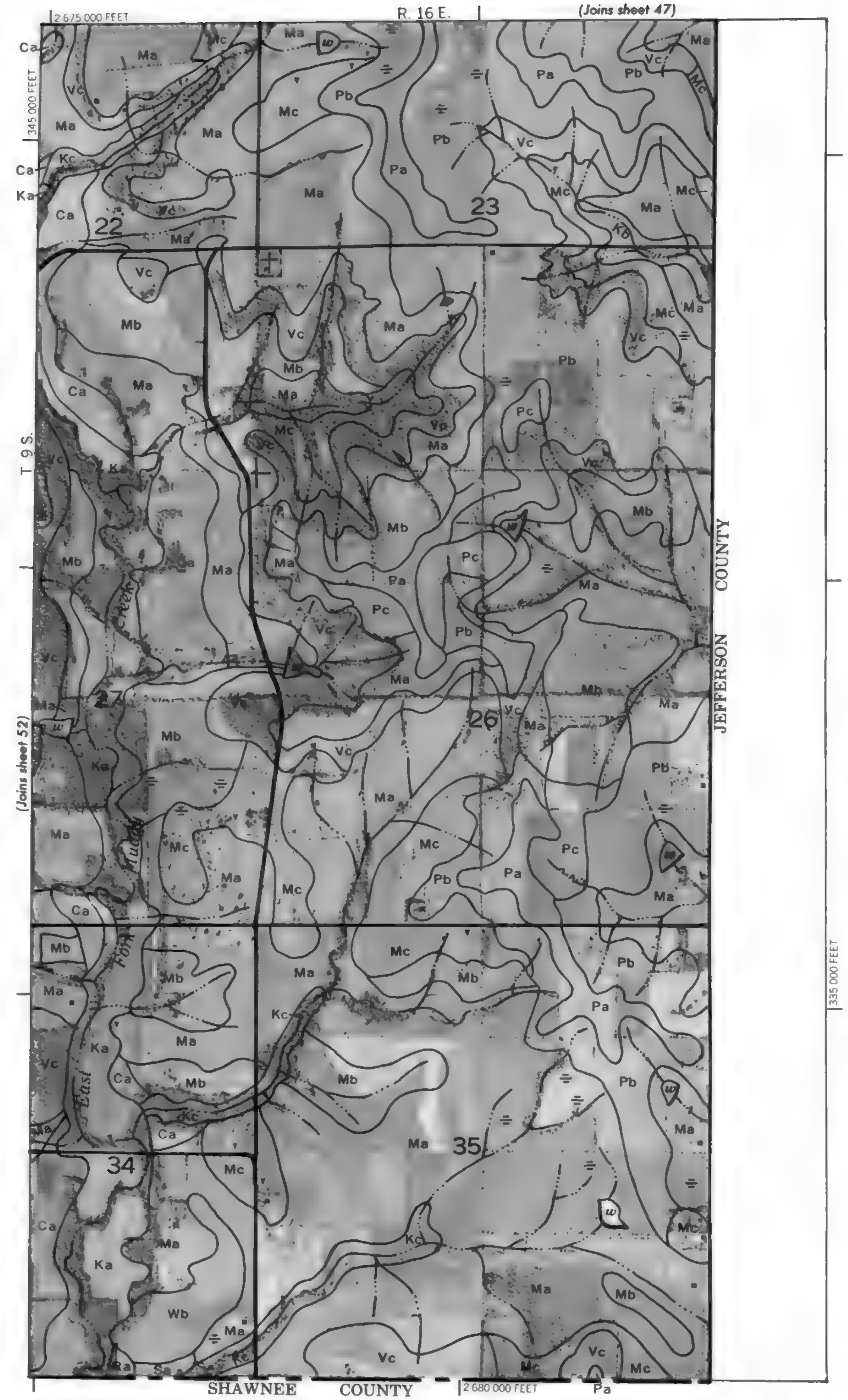
2 630 000 FEET
R. 15 E.
(Joins sheet 40)
350 000 FEET
T. 9 S.
(Joins sheet 44)
(Joins sheet 46)
(Joins sheet 51)
2 650 000 FEET
POTAWATOMI
INDIAN
RESERVATION
Little Soldier Creek
Little Elm Creek
Big Elm
CHICAGO ROCK ISLAND AND PACIFIC
HOYT CEMETERY
75
N
1 Mile
5000 Feet
Scale 1:20000
This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

JACKSON COUNTY, KANSAS — SHEET NUMBER 46

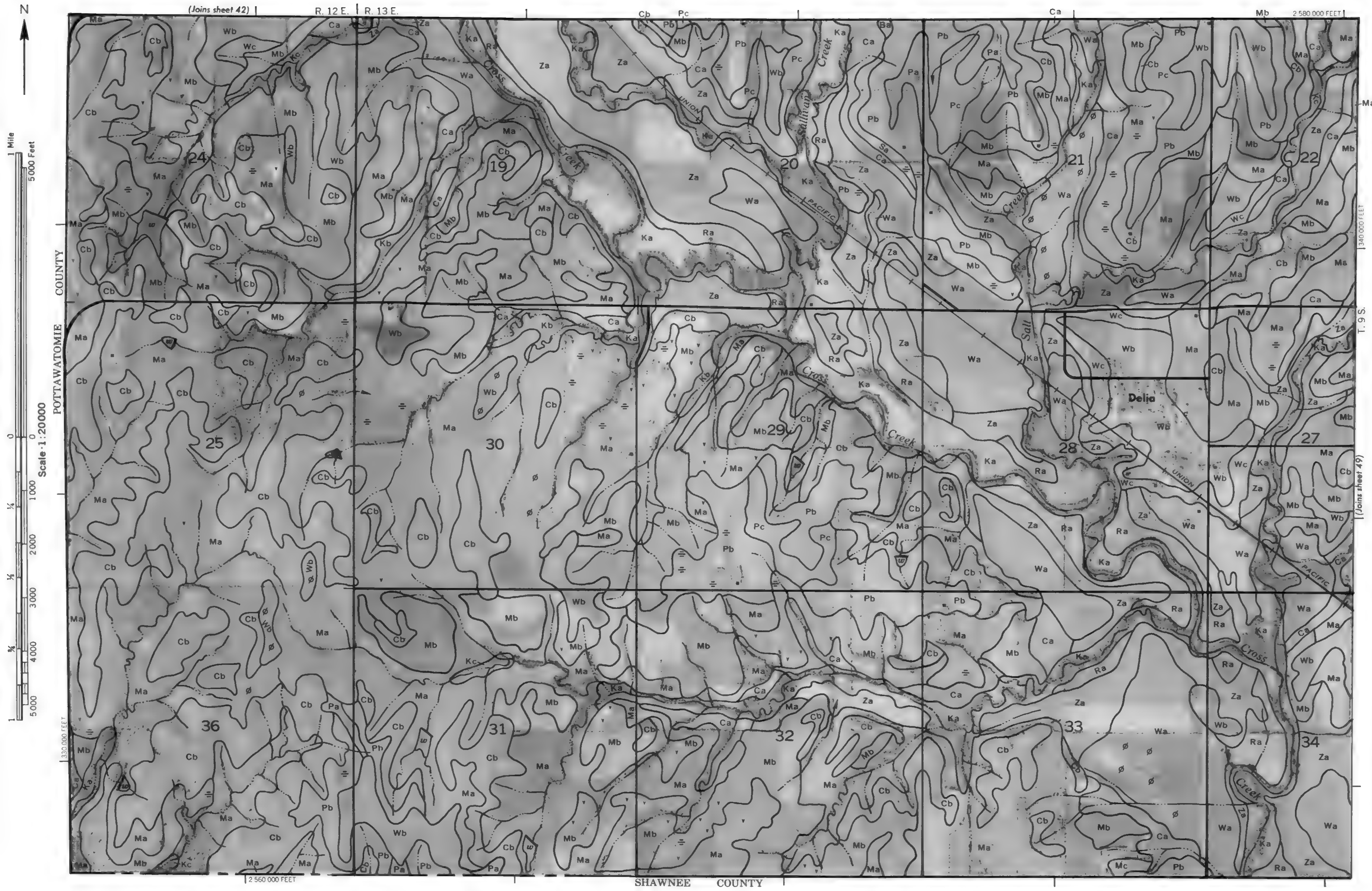


This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.


2 675 000 FEET
R. 16 E.
(Joins inset, sh 36)
350 000 FEET
T 9 S.
(Joins sheet 46)
JEFFERSON COUNTY
(Joins inset, sheet 47)
2 680 000 FEET
3
2
10
11
15
14


2 675 000 FEET
R. 16 E.
(Joins sheet 47)
345 000 FEET
T 9 S.
(Joins sheet 52)
JEFFERSON COUNTY
335 000 FEET
SHAWNEE COUNTY
2 680 000 FEET
22
23
27
26
34
35
East Fork Muddy Creek

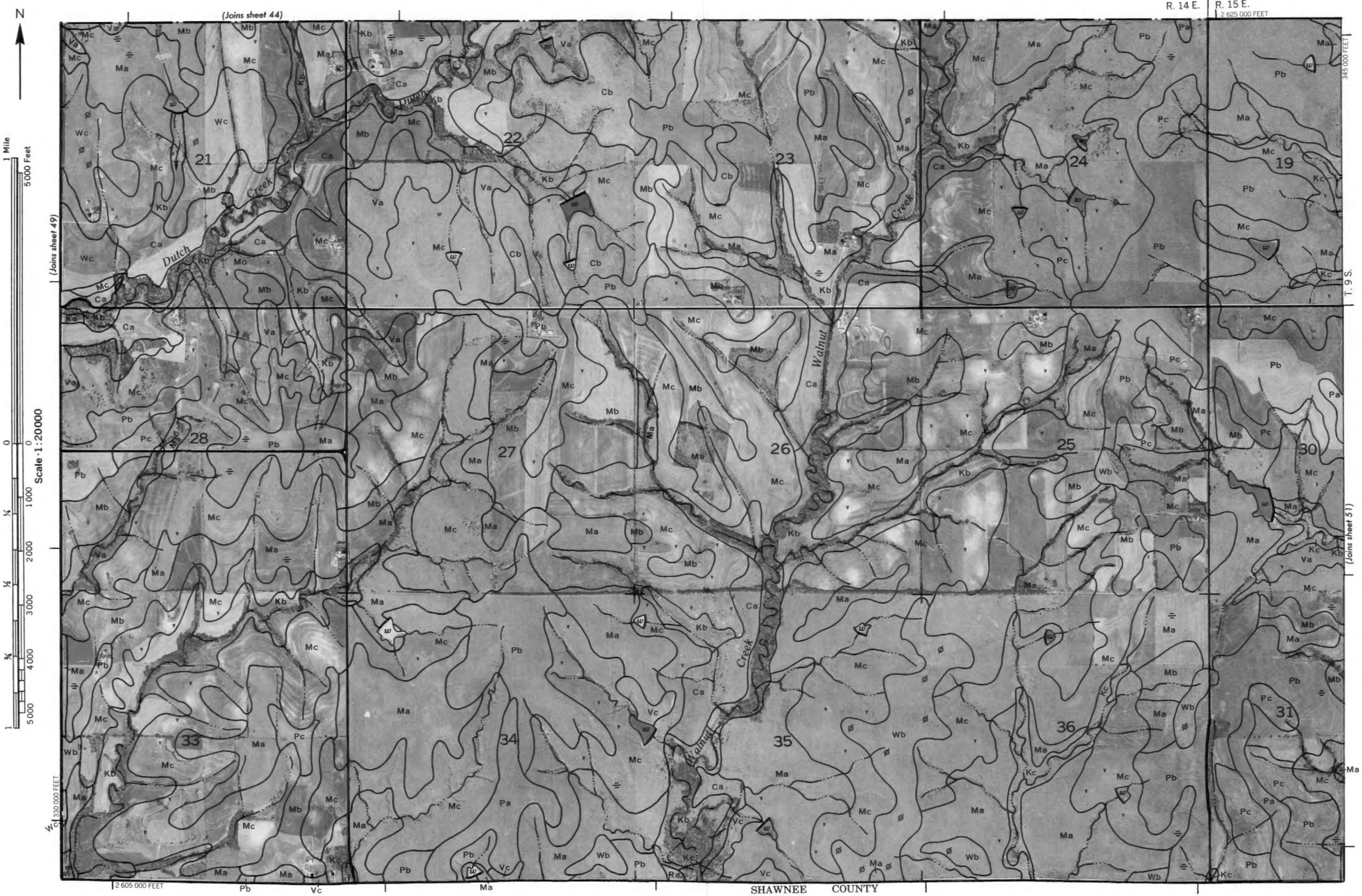

N
1 Mile
5000 Feet
Scale 1:20000



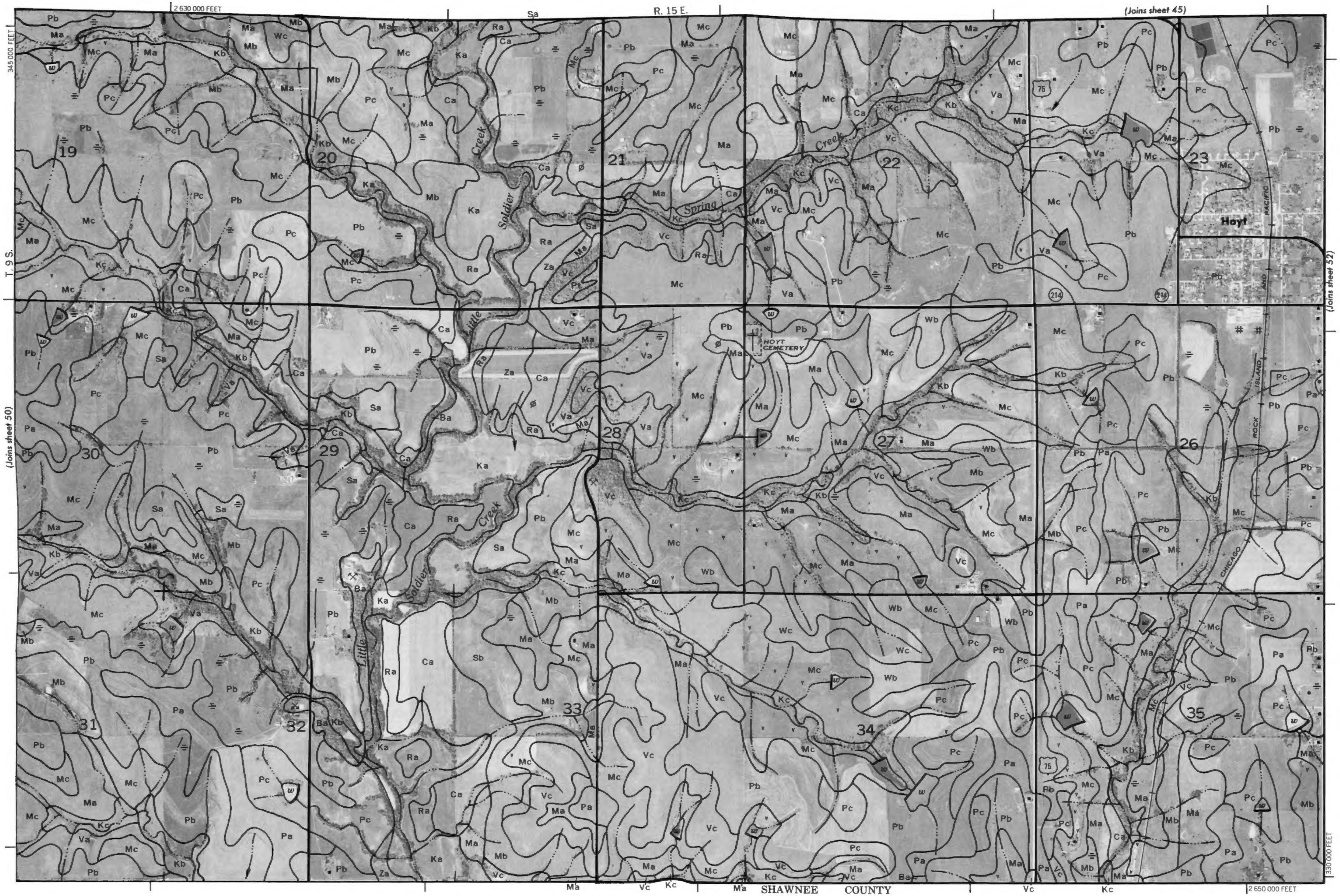
This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

JACKSON COUNTY, KANSAS — SHEET NUMBER 50



This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



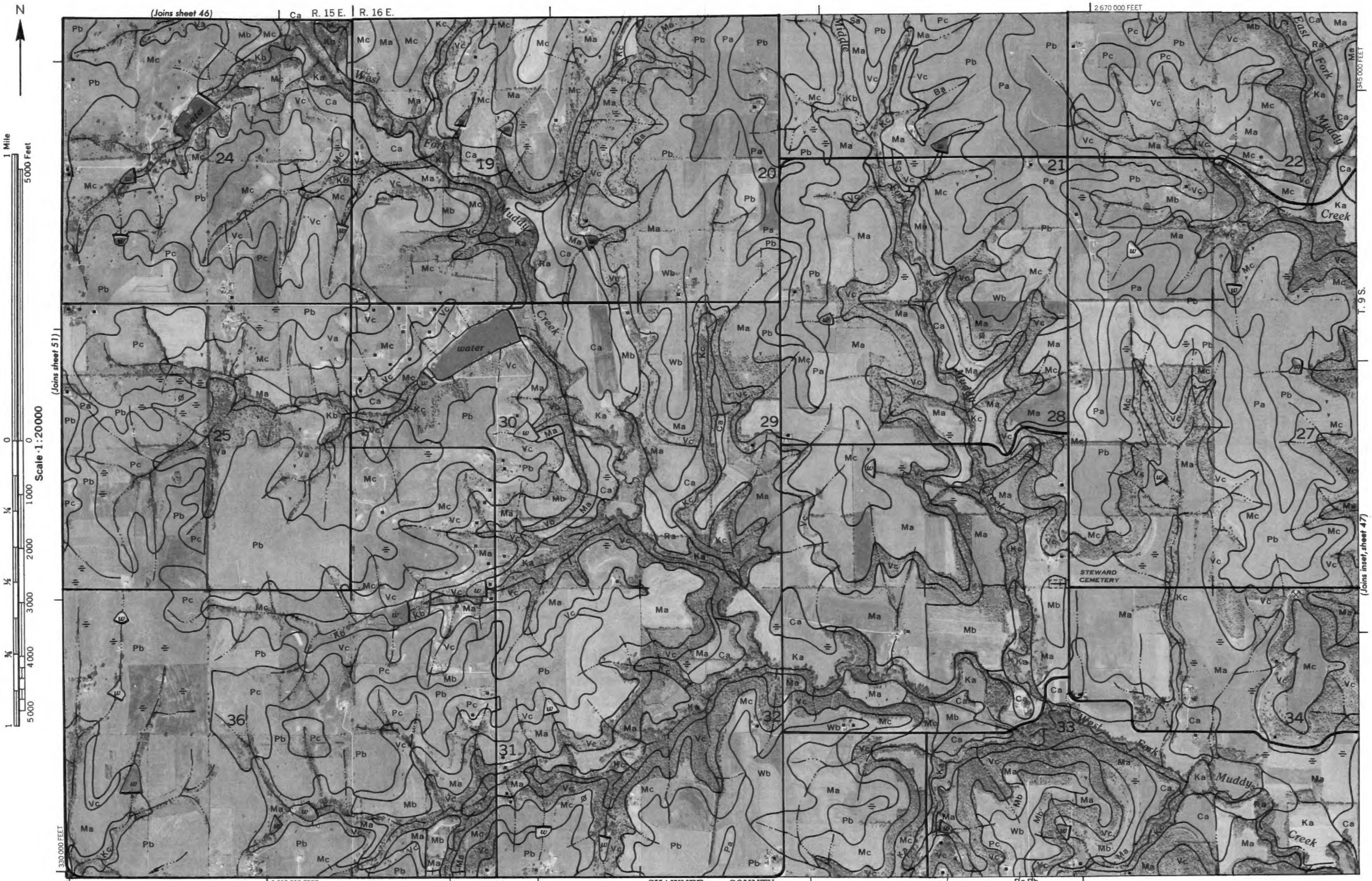
N

1 Mile
5000 Feet
0
1/4
1/2
3/4
1

0
1000
2000
3000
4000
5000

Scale 1:20000

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.